## 4.3 Fish

### 4.3.1 Threatened and Endangered Fish Species

This section discusses the predicted, direct, environmental consequences of the Proposed Action or alternatives with respect to listed salmonid species found within the action area: Puget Sound chinook salmon, Hood Canal summer chum salmon, bull trout, Columbia River chinook salmon, and Columbia River chum salmon. The following discussion will address these species in this order. Indirect and cumulative impacts are discussed in Section 4.3.8.

**Puget Sound Chinook and Hood Canal Summer Chum**

Standards of Comparison for Puget Sound Chinook

The Puget Sound Chinook Salmon Evolutionarily Significant Unit (ESU) was listed as threatened in 1999 because the potential for these populations to become endangered in the foreseeable future was believed to be high if current conditions continued (Meyer et al. 1998). Harvest is identified as one factor of decline in the listing decision. The co-managers anticipate the vast majority of the harvest-related mortality to listed Puget Sound chinook salmon over the duration of the Resource Management Plan (RMP) will be incidental to fisheries directed at other stocks or species (~~NMFS 2004~~WDFW and PSIT 2004~~ [4(d) determination]~~). Nevertheless, over the past decade, the co-managers have constrained harvest mortality, severely for some populations in the ESU, to avoid escapement falling to the point of instability. These harvest reductions have been in response to significant reductions in productivity and capacity of chinook salmon-bearing watersheds throughout Puget Sound, largely as a result of habitat degradation. The National Marine Fisheries Service (NMFS) has found these harvest actions are consistent with the requirements of the Endangered Species Act (ESA) (NMFS 1999; NMFS 2001; NMFS 2003; Puget Sound Treaty Tribes and Washington Department of Fish and Wildlife 2003).

The potential impacts of the Proposed Action or alternatives on listed Puget Sound chinook salmon are quantified in terms of the projected total fisheries exploitation rate and resulting spawning escapement for each population. In general terms, *exploitation rate* is the number of fish harvested from each population divided by the number of fish in the population[vi] (see Appendix C). *Spawning escapement* is the estimated number of fish that return to the spawning grounds each year. For some populations,

[vi] The total exploitation rate is technically defined as the proportion of adult chinook, from all year-classes, prior to the onset of fishing in a given year, harvested or killed incidentally as a result of fishing.

spawning escapement is measured in terms of those fish whose parents spawned naturally rather than in hatcheries or by other artificial propagation means.

Survival and recovery of the Puget Sound Chinook ESU will depend, over the long term, on necessary actions in other sectors, especially habitat actions, and not on harvest actions alone. There is an ongoing recovery planning effort for the Puget Sound Chinook ESU. Completion of the recovery plan and decisions regarding the form and timing of recovery efforts described in the recovery plan will determine the kinds of harvest actions that may be necessary and appropriate in the future. Absent that guidance at the time of this writing, NMFS must evaluate the proposed harvest actions by examining the impacts of harvest within the current context. Therefore, NMFS has evaluated the future performance of populations in the ESU under recent productivity conditions; i.e., assuming that the impact of hatchery and habitat management actions remain as they are now. The actual performance of the populations will vary due natural variability in freshwater and marine survival, and may also vary due to actions in the habitat and hatchery sectors. For example, if habitat and hatchery actions improve conditions over currently existing conditions, the current NMFS conservation standards would be conservative, likely overestimating the impact that harvest actions would have on the ESU.

Where available, exploitation rates and spawning escapement are compared to population-specific conservation standards established by the NMFS to ascertain whether fisheries will appreciably reduce survival and recovery of the ESU, as required by the ESA 4(d) Rule. Conservation standards are represented by rebuilding exploitation rates, critical escapement thresholds, and viable escapement thresholds.

The rebuilding exploitation rates (RERs) represent the highest rate of harvest that will achieve the following ESA conservation criteria. Over the long term (25 years), harvest at the RER level will achieve: 1a) a high (80%) probability of rebuilding, or 1b) no more than a 10 percent reduction in the probability of rebuilding, and 2) a very low (5%) probability of the population falling to the critical threshold (see Appendix A) compared with a zero-harvest baseline. Fishing regimes that exert harvest rates below the RER level, by definition, do not pose jeopardy to the ESU. Fishing regimes above the RERs may also not pose jeopardy to the ESU depending on the status and distribution of the chinook salmon populations throughout the ESU.

The *critical escapement threshold* (CET) represents a point of biological instability, below which the risk of extinction increases significantly, due to declining spawning success, depensatory mortality, or risk of loss of genetic integrity. This threshold is not precisely known for any population, but may be estimated by risk assessment if the current productivity of a population can be estimated. Based on theoretical assessment of ecological and genetic risk (McElhaney et al. 2000; and NMFS 2001), a generic critical threshold of 200 adults has been used for other populations for which population-specific data are unavailable or insufficient to estimate productivity. *Viable escapement thresholds* (VETs) in the context of this EIS analysis are a level of spawning escapement associated with rebuilding to recovery, consistent with current environmental conditions. For most populations, these thresholds are well below the escapement levels associated with recovery, but achieving these goals under current conditions is a necessary step to eventual recovery when habitat and other conditions are more favorable. Where data are available, viable escapement thresholds have been defined consistent with the current productivity and capacity of spawning habitat. Where such information is not available, the generic viable threshold (1,250 adults) defined by NMFS for Viable Salmonid Populations (McElhany et al. 2000; NMFS 2001) is used as a reference point. By definition, these thresholds offer only general guidance as to what generally represents points of stability or instability. Some populations may be fairly robust at very low abundances, while chinook salmon populations in large river systems may become unstable at higher abundances depending on resource location and spawner density. However, without population-specific information, NMFS believes these generic guidelines offer the best available information.

NMFS has developed specific conservation standards for 12 of the 22 populations and one management unit (Nooksack early) within the Puget Sound Chinook ESU (Table 4.3-1). Nine of these 12 populations and one management unit have estimates of rebuilding exploitation rate (RER), critical escapement threshold (CET), and viable escapement threshold (VET). Although RERs have not been established for the Upper Cascade spring or Snoqualmie chinook populations, ancillary information indicated that the RERs developed for other populations within their management units should be protective of these populations (Susan Bishop, NMFS, April 20, 2003; and Skagit Rebuilding Exploitation Rate Workgroup 2003). The remaining populations have a mixture of specific and generic standards – also developed by NMFS (McElhany et al. 2000). Standards for all populations are summarized in Table4.3-1. NMFS uses all of this information to assess the status and distribution of the chinook salmon populations throughout the ESU, and then to determine whether the harvest action would pose jeopardy to the ESU as a whole.

The model used for this EIS analysis estimated fishery impacts to chinook salmon and other species in Alaska, British Columbia, and *Southern U.S. Fisheries* – those occurring in Puget Sound and off the Pacific coast of Washington, Oregon, and California (see Technical Appendix B). Within the Southern

U.S. area, more than 95 percent of the catch of species discussed here occurs within Puget Sound (Pacific Salmon Commission 2002).

Subsection 4.3.1 compares the impacts of the Proposed Action or alternatives on Puget Sound chinook under each of four scenarios as described in Subsection 4.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis. Each scenario defines a different baseline condition in terms of forecast abundance of Puget Sound Chinook and harvests occurring in fisheries in Canada and Alaska.

These different scenarios are used only to explore the range of possible impacts to chinook salmon. The assumptions regarding the range of abundance and Canadian/Alaskan fisheries for coho, sockeye, pink, chum, and steelhead are the same among scenarios for two reasons: 1) the purpose of the Proposed Action is to manage Puget Sound chinook salmon. It does not include management objectives for other species or describe how fisheries will respond to changes in abundance of those other salmon species; and 2) the 1999 Pacific Salmon Treaty Chinook Annex provides the necessary information to model chinook salmon impacts under higher levels of fishing than those observed in recent years, but which might occur in the next few years. However, there is insufficient information to allow NMFS to model how catch of salmon species other than chinook would vary in response to changes in Canadian/Alaskan fisheries. Therefore, the analysis assumes abundance and Canadian/Alaskan fishery impacts for non-chinook salmon species will remain similar to those experienced in recent years.

Table 4.3-1. Rebuilding Exploitation Rates, and critical and viable escapement standards for listed Puget Sound chinook and Hood Canal summer chum, against which impacts of Alternatives were assessed.

| Population | Rebuilding Exploitation Rate | Critical escapement | MSY, viable, or capacity escapement level |
|---|---|---|---|
| Nooksack Spring | 12% | | 500 |
| North Fork | | 200 | |
| South Fork | | 200 | |
| Skagit Summer-Fall | | | |
| Lower Skagit | 49% | 251 | 2182 |
| Lower Sauk | 51% | 200 | 681 |
| Upper Skagit | 60% | 967 | 7454 |
| Skagit Spring | | | |
| Upper Cascade | | 170 | |
| Upper Sauk | 38% | 130 | 330 |
| Suiattle | 41% | 170 | 400 |
| Stillaguamish Summer-Fall | | | |
| North Fork | 32% | 300 | 552 |
| South Fork | 24% | 200 | 300 |
| Snohomish Summer-Fall | 18% | | |
| Skykomish | 18% | 1650 | 3500 |
| Snoqualmie | | 400 | |
| Green | 53% | 835 | 5523 |
| Lake Washington | | | |
| Sammamish | | 200 | 1200 |
| Cedar | | 200 | 1200 |
| Puyallup | | 200 | 1200 |
| White River Spring | | 200 | 1000 |
| Nisqually | | 200 | 1100 |
| Mid- Hood Canal / Dosewallips | | 200 | 1250 |
| Skokomish | | 200 | 1250 |
| Dungeness | | 200 | 925 |
| Elwha | | 200 | 2900 |
| Hood Canal – Juan de Fuca Summer Chum Populations | | | |
| Hood Canal | 11% | 4070 | |
| Strait of Juan de Fuca | 9% | 920 | |

| Scenario | Pre-Action Resource Status [vii] | |
|---|---|---|
| | Abundance | Harvest in Canadian/Alaskan Fisheries |
| Scenario A | 2003 | 2003 |
| Scenario B | 2003 | Maximum expected under the 1999-2008 Pacific Salmon Treaty Annex |
| Scenario C | 70% of 2003 | 2003 |
| Scenario D | 70% of 2003 | Maximum expected under the 1999-2008 Pacific Salmon Treaty Annex |

Scenario B is considered the most likely scenario during the RMP implementation period; therefore, the analysis emphasizes this scenario. However, the performance of each alternative is compared both across the four scenarios, and with each of the other alternatives for a given scenario. For example, Alternative 2 is evaluated for Scenarios A through D. Then Alternative 2, Scenario A is compared with Alternative 1, Scenario A, and so forth.

Table 4.3-3 in Subsection 4.3.1.5, Summary Discussion of Alternatives, summarizes the performance of each alternative (under Scenario B) in relation to the conservation standards for those populations. Table 4.3-4 in Subsection 4.3.1.5 summarizes the impacts of Alternatives 2 through 4 relative to Alternative 1, the Proposed Action, under Scenario B. Table 4.3-5 in Subsection 4.3.1.5 summarizes performance of each alternative under all scenarios relative to conservation standards, and Table 4.3.6 summarizes impacts of Alternatives 2 though 4 for all scenarios. Additional tables in this Subsection 4.3.1.5 (and in Appendix B) provide more detailed information on exploitation rates, total fishery-related mortality for hatchery and natural chinook salmon (landed and non-landed), and escapement of hatchery and naturally-spawning chinook salmon.

Standards of Comparison for Hood Canal Summer Chum

There are seven summer chum salmon populations in the listed Hood Canal-Strait of Juan de Fuca summer chum ESU. NMFS has determined that over the long term, fisheries exploitation rates should be constrained to an average of 10.9 percent or less for Hood Canal component salmon and 9 percent or less for Strait of Juan de Fuca component of the Hood Canal/Strait of Juan de Fuca ESU. This standard

[vii] Represents preseason projections of 2003 fisheries and abundance.

allows that, in any one year, exploitation rates may vary from 3 to 15 percent for the Hood Canal component, and from 3 to 12 percent for the Strait of Juan de Fuca component. Fisheries should result in appropriate distribution of escapement among the various populations in each region, and should not otherwise impede the survival and recovery of the ESU (NMFS 2000). For summer chum, exploitation rates are expressed as total catch (in all fisheries) as a proportion of the sum of catch and escapement. However~~, returns to the Quilcene River~~ Quilcene summer-chum stock (Quilcene/Dabob Bay Management Unit) (for which the run is dominated by a large summer chum hatchery program) are excluded from the exploitation rate calculation. Critical escapement goals have also been designated: 4,070 for the Hood Canal summer chum region, and 920 for the Strait of Juan de Fuca region.

**Bull Trout, and Columbia River Chinook and Chum Salmon**

A small number of anadromous char, presumed to be bull trout, are caught in freshwater sport fisheries and may be caught in near-shore salmon net fisheries primarily in northern Puget Sound. Listed Columbia River-origin chinook and chum salmon are infrequently caught in Puget Sound (personal communication via e-mail from Dell Simmons, NMFS, to Susan Bishop, NMFS Sustainable Fisheries Division, December 2002).

Fishery closures under Alternative 2, 3 or 4 would slightly reduce the rare catch of these species that might occur under Alternative 1, but neither the Proposed Action nor the Alternatives would exert a measurable impact on these species under any of the harvest management scenarios. Therefore, bull trout and the Columbia River ESUs will not be discussed further in this document.

Metrics for Comparison of Impacts

The Proposed Action (Alternative 1) serves as the baseline against which the other alternatives are measured. The magnitude of the impacts of Alternatives 2, 3, or 4 relative to the baseline are classified as follows:

| Term | When the impact varies by: |
|---|---|
| None | Not measurable, rare, infrequent |
| Low | Less than 10 percent |
| Moderate | 10 percent to 30 percent |
| Substantial | More than 30 percent |

Although it is useful and necessary to provide some system of metrics against which to assess the effects of the Proposed Action or alternatives, the complexity of salmon life history means that the magnitude of changes in effect may not translate into realized benefits or risks to the populations of the same magnitude. Therefore, it is important to note that there are several limitations to the application of these metrics to fish that should be taken into account in interpreting the results of applying these metrics. First, substantial increases in spawning escapements may not result in commensurate increases in the progeny of those spawners. The objective for salmon fisheries management is to constrain fishing mortality to the extent necessary to optimize the production of subsequent generations. The *productivity* of salmon populations, often defined in terms of the number of recruits produced per female spawner, increases over a range of escapement, then reaches a plateau or declines at higher levels of escapement due to density-dependent survival; i.e., too many spawners for the available habitat, or too many juvenile salmon for the available food in the river. The escapement level corresponding to the point of optimum productivity varies widely among individual populations due to the accessible area of suitable spawning and rearing habitat within a river system, and the very complex array of physical and biological factors that influence the annual survival of salmon eggs and juveniles through their freshwater life history. However, the influence of these physical and biological factors varies greatly from year to year, so that were fisheries management to achieve optimum escapement consistently from year to year, the actual production from those spawners would still vary widely. The marine environment exerts even greater influence on the number of juvenile salmon that reach adulthood. Consequently, this Environmental Impact Statement can compare the predicted escapement for populations against specific or general escapement standards, but cannot accurately project the resulting abundance of subsequent generations of adult salmon. Also, changes in risk relative to achievement of the Rebuilding Exploitation Rates may not be the same as changes in risk measured by changes in escapement. That is, the changes in achieving the Rebuilding Exploitation Rates are likely to be more beneficial or adverse relative to recovery than changes in escapement.

It should also be noted that changes in exploitation rates are expressed in the discussion below as the difference – in percentage points – between two rates, whereas changes in escapement are expressed as the percent difference between two values. For example, if the exploitation rate for Nooksack early chinook is 20 percent under Alternative 1 and 15 percent under Alternative 2, the change is 5 percentage points (20% minus 15% = 5%). If the escapement of Nooksack early chinook changes from 200 under Alternative 1 to 250 under Alternative 2, the change is 25 percent ([250 minus 200] divided by 200).

#### 4.3.1.1 Alternative 1 – Proposed Action/Status Quo

Alternative 1 (the Proposed Action) is the alternative that most closely resembles recent historical harvest management plans. Its implementation is predicted to result in exploitation rates below rebuilding exploitation rate (RER) ceilings for five of the nine populations and one management unit that have RER standards. With the exception of the Nooksack early management unit, escapements under this alternative are predicted to exceed critical thresholds for all populations under all scenarios, in most cases by substantial margins. Viable escapement thresholds (VETs) are predicted to be met or exceeded for nine of the 18 populations and one management unit that have VET standards.

**<u>Summary of Scenario Differences</u>**

Under Alternative 1, Scenarios A, C, or D, representing conditions similar to 2003 (A); decreased forecast abundance (C); or decreased forecast abundance with maximized Canadian/Alaskan fisheries (D), the predicted Southern U.S. catch from listed Puget Sound populations is 106 percent, 74 percent, and 71 percent respectively of that under Scenario B (see Table 4.3-2 in Subsection 4.3.1.5, Summary Discussion of Alternatives). Catch of other species is discussed in Subsection 4.3.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis.

Exploitation rates under Alternative 1, Scenarios A, C, and D are predicted to vary from those under Alternative 1, Scenario B, by 1 to 5 percent. Exploitation rates for the Nooksack population, which exceeded RER ceilings under Alternative 1, Scenario B, also are predicted to exceed RER ceilings under Scenarios A, C, or D by margins of 8 to 14 percent. Exploitation rates for the Skykomish River chinook salmon population are also predicted to exceed the RER ceiling under all scenarios by margins of 1 percent to 5 percent. Exploitation rates for the Lower Skagit River fall and Lower Sauk River summer chinook populations, which were not predicted to meet RER ceilings under Alternative 1, Scenario B, were below the ceiling under Alternative 1, Scenarios A or C, by 1 to 3 percent, and above the RER ceiling under Scenario D by 5 to 7 percent. The exploitation rate for the Green River fall chinook population is predicted to exceed the RER ceiling under Alternative 1, Scenario A, by 9 percent, but is predicted to be 4 to 5 percent below the ceiling under Scenarios C or D (see Table 4.3-5 and Table 4.3-7a through Table 4.3-7d in Subsection 4.3.1.5).

Except for the Nooksack early populations, all populations that met CETs under Alternative 1, Scenario B, are predicted to meet them under Scenarios B, C, or D, as well. The North Fork Nooksack River early chinook salmon population is not predicted to meet CETs in any scenario under Alternative 1. The South Fork Nooksack population is not predicted to meet its CET under Scenarios C or D. The Upper Skagit River summer chinook population, which was predicted to meet its VET goal under Alternative 1, Scenario B, was also predicted to meet it under Alternative 1, Scenario A, but to fall slightly below goal under Alternative 1, Scenarios C or D. This was also true for the South Fork Stillaguamish fall population. Other populations that would meet or exceed VET goals under Scenario

B would meet or exceed them under the other scenarios, and those that were predicted to fall below goal under Scenario B also did so under the other scenarios (see Table 4.3-5 in Subsection 4.3.1.5).

**Impacts to Puget Sound Chinook Populations**

Under Alternative 1, Scenario B (high abundance and Canadian/Alaskan fisheries at the maximum allowed by treaty), the fishery model projected Southern U.S. catches of 52,720 chinook from naturally-spawning Puget Sound populations, and 1,663 chum from listed Hood Canal/Strait of Juan de Fuca summer populations. An additional 81,570 chinook from hatcheries and streams outside the action area are predicted to be caught (see Table 4.3-2 in Subsection 4.3.1.5).

Under Alternative 1, Scenario B, exploitation rates are predicted to be below their RERs for five of the nine populations and one management unit for which RERs have been derived (see Table 4.3-3 in Subsection 4.3.1.5). Exploitation rates are predicted by the fisheries model to exceed RER standards for the Nooksack early management unit by 13 percentage points, despite the fact that the Southern U.S. exploitation rate is predicted to be only 7 percentage points. The Lower Skagit River population is predicted to exceed its RER ceiling by 6 percentage points, the Lower Sauk River population by 4 percentage points, the Skykomish River population by 4 percentage points, and the Green River chinook salmon population by 10 percentage points. However, owing to peculiarities associated with the 2003 base year data for the Skagit summer/fall chinook salmon populations, it is likely that the model predicts higher exploitation rates than may actually occur [viii] during implementation of the Proposed Action (NMFS 2004 [4(d) determination]). It is also important to note that for the Skagit River summer-fall chinook populations, the predicted Southern U.S. exploitation rate (16%) accounted for less than one-fourth of the total predicted exploitation rate (55%) (see Table 4.3-3 and detail Table 4.3-7b in Subsection 4.3.1.5). The model predicted that exploitation rates for six populations would fall below RER ceilings under Alternative 1, Scenario B, by margins of 5 to 13 percentage points. These include exploitation rates for the upper Skagit, Upper Sauk and Suiattle chinook populations (11% and 14%, respectively, below the RER ceiling), the North Fork Stillaguamish and the South Fork Stillaguamish chinook populations (13% and 5%, respectively, below the RER ceiling) (see Table 4.3-7b in Subsection 4.3.1.5). The model predicted that, under Alternative 1, Scenario A, exploitation rates

[viii] Anomalous age structure and the presence of pink salmon fisheries in 2003 make the estimates of exploitation rates liberal, The Southern United States exploitation rates are more likely to be similar to recent years; i.e., 6 to 18 percent

for two additional populations – the lower Skagit fall and Lower Sauk summer populations – would fall below their RER ceilings (1% and 3%, respectively) (see Table 4.3-7a in Subsection 4.3.1.5).

The majority of harvest for the Nooksack early and Skagit summer/fall occurs in Canadian fisheries. The RER for the Nooksack early chinook management unit is predicted to be exceeded even without Southern U.S. fishing. For the Nooksack early chinook management unit, harvest mortality in Southern U.S. fisheries is predicted to increase the probability of falling below its CET by 21 percentage points and decrease the probability of rebuilding by 6 percentage points, measured over 25 years. For the Skagit summer/fall chinook salmon populations, harvest mortality in Southern U.S. fisheries is predicted to keep the probability of falling below its CET below 5 percentage points and decrease the probability of rebuilding by 26 percentage points, measured over 25 years. It should be noted that these are probably maximum estimates since the calculations are based on low marine survival assumptions, and recent information indicates that marine survival may be improving. Both the Skagit River summer/fall populations are currently above their VETs and have shown increasing trends in escapement.

Under Alternative 1, Scenario B, only the North Fork Nooksack chinook salmon population is predicted to not meet its CET. For most other populations, escapements are predicted to exceed critical thresholds by more than 100 percent. Escapement is predicted to exceed the viable escapement threshold for nine populations, including: Upper Skagit River, Upper Sauk River, Suiattle River, North Fork Stillaguamish and South Fork Stillaguamish, Green River, White River, Puyallup River, and Nisqually River. Escapement under Alternative 1, Scenario B, is predicted to be below the VET for 10 chinook populations and one management unit, including: Nooksack River early, Lower Skagit River, Lower Sauk River, Skykomish River, Sammamish River, Cedar River, Mid-Hood Canal, Skokomish, Dungeness, and Elwha chinook salmon populations (see Table 4.3-3 in Subsection 4.3.1.5).

In summary, implementation of Alternative 1 (the Proposed Action), Scenario B, is predicted to result in exploitation rates below RER ceilings for five of the nine populations and one management unit with RER standards. Critical escapement thresholds are predicted to be exceeded for all populations except the Nooksack early management unit, in most cases by substantial margins. Viable escapement thresholds are predicted to be met or exceeded for nine of the 18 populations and one management unit with thresholds, including Upper Skagit; Upper Sauk and Suiattle, North Fork and South Fork Stillaguamish, Green River, Puyallup, White, and Nisqually River chinook salmon populations (see Table 4.3-5 and Tables 4.3-7a through 4.3-7d in Subsection 4.3.1.5).

The Puget Sound Technical Recovery Team (TRT) has identified five distinct geographic/life history regions in the Puget Sound Chinook Salmon ESU: the Strait of Georgia, North Puget Sound, South Puget Sound, Hood Canal, and Strait of Juan de Fuca. Current TRT guidance recommends that a recovered ESU would have two to four low-risk populations within each region, representative of the range of life histories within each of the regions. Under Alternative 1, the Nooksack early management unit that makes up the Strait of Georgia region is predicted to exceed its RER; five of the eight [ix] North Puget Sound populations are predicted to meet their RER and/or exceed the VETs; four of the six South Puget Sound populations are predicted to exceed their VETs; and none of the populations in the Strait of Georgia, Hood Canal, or Strait of Juan de Fuca regions are predicted to exceed their VETs. Except for the North Fork Nooksack chinook population, all populations in all regions are predicted to exceed their CETs.

NMFS is currently evaluating Alternative 1, as proposed by the co-managers in the Puget Sound Chinook Management Plan, under the ESA 4(d) Rule. Taking into account the distribution of population status throughout the ESU and other relevant factors, NMFS has preliminarily concluded that Alternative 1 would not appreciably reduce the likelihood of survival and recovery of the ESU (NMFS 2004~~*in press*~~).

**Impacts to Hood Canal and Strait of Juan de Fuca Summer Chum**

The fisheries modeled under Alternative 1 (the Proposed Action) are predicted to result in a Southern U.S. catch of ~~141~~ 1,651 Hood Canal and 12 Strait of Juan de Fuca summer chum salmon (excluding those from the Quilcene/Dabob Bay management unit.~~,~~ However, the majority of the Hood Canal summer chum catch is comprised of fish from the Quilcene/Dabob Bay Management Unit, which are managed for an escapement goal and treated separately under the Summer Chum Salmon Conservation Initiative). Escapement in this management unit is dominated by production from the Big Quilcene hatchery. Excluding the Quilcene/Dabob Bay Management Unit harvest, the Southern U.S. catch of Hood Canal summer chum is expected to be 214 and ~~T~~the exploitation rates (including Canadian catch) are predicted to be 3~~2~~ percent for the Hood Canal region and 0.4 percent for the Strait of Juan de Fuca region, well below the long-term goals of the Summer Chum Salmon Conservation Initiative of 10.9 percent for Hood Canal summer and 9 percent for Strait of Juan de Fuca summer chum (Washington Department of Fish and Wildlife and Point-No-Point Treaty Tribes, Summer Chum Salmon

[ix] There are ten populations in the North Puget Sound Region, but only eight currently have identified management standards.

Conservation Initiative, April 2000). The predicted escapement of ~~11,454~~ 7,437 Hood Canal summer chum (11,454 including the Quilcene/Dabob Bay Management Unit) and 6,955 Strait of Juan de Fuca summer chum exceeds the critical escapement goals for these regions by ~~181~~ 83 percent and 656 percent, respectively (see Table 4.3-7a in Subsection 4.3.1.5).

### 4.3.1.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Alternative 2 represents a more restrictive fishing regime than Alternative 1, especially for populations in North Puget Sound. With three notable exceptions (discussed below), escapements are predicted to be higher for most populations compared to Alternative 1.

**Summary of Scenario Differences**

Under Alternative 2, Scenarios A, C, or D, representing conditions similar to 2003 (A); decreased forecast abundance (C); or decreased forecast abundance with maximized Alaskan and Canadian fisheries (D), Southern U.S. catch of naturally-spawning chinook salmon is predicted to be 123 percent, 71 percent, and 69 percent respectively of that under Scenario B. Catch of other species is discussed in Subsection 4.3.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis.

Exploitation rates for the Nooksack early chinook management unit, the North Fork Stillaguamish population, and the South Fork Stillaguamish population, which are predicted to exceed RER ceilings under Alternative 2, Scenario B, are also predicted to exceed RER ceilings under Scenarios A, C, or D. Exploitation rates for the Skykomish River and Green River populations are predicted to exceed the RER ceilings under Scenarios A or B, but are predicted to be below the RER ceilings for Scenarios C or D. Escapements for Alternative 2, Scenario A, are predicted to be generally lower than escapements under Alternative 2, Scenario B and escapements under Alternative 2, Scenarios C or D are predicted to be generally higher (see Table 4.3-5 and Tables 4.3-8a through 4.3-8d in Subsection 4.3.1.5). Nevertheless, populations (other than the Nooksack River population) predicted to meet CETs under Scenario B are also predicted to meet CETs under Scenarios A, C, or D, as well. The South Fork Stillaguamish population is not predicted to meet its CET in any scenario under Alternative 2. Populations predicted to meet or exceed VET goals under Alternative 2, Scenario B, are also predicted to meet or exceed them under Alternative 2, Scenario A. With one exception, (Lower Sauk River), populations predicted to meet or exceed VETs under Alternative 2, Scenario B, would meet or exceed VETs under Alternative 2, Scenarios C or D (see Table 4.3-5 and Tables 4.3-8a through 4.3-8d in Subsection 4.3.1.5).

**Comparison of Alternative 2 (Escapement Goal Management at the Management Unit Level) to the Proposed Action**

Impacts to Puget Sound Chinook Populations

Under Alternative 2, Scenario B (high abundance and Canadian/Alaskan fisheries at the maximum allowed by treaty), the fishery model projected Southern U.S. catches of 42,793 chinook from naturally-spawning chinook Puget Sound chinook populations, or 11,743 fewer than with Alternative 1, Scenario B. It is predicted that an additional 36,074 chinook salmon from hatcheries and from streams outside the action area would be caught, which is 75,857 fewer than under Alternative 1, Scenario B (see Table 4.3-2 in Subsection 4.3.1.5).

Under Alternative 2, Scenario B, the total exploitation rate for the Nooksack early management unit is predicted to exceed its RER ceiling by 7 percentage points, despite the fact that the Southern U.S. exploitation rate is predicted to be only 1 percent. The exploitation rate for the North Fork Stillaguamish population is predicted to exceed the RER ceiling by 35 percentage points, the South Fork Stillaguamish population by 43 percentage points, the Skykomish River population by 5 percentage points, and the Green River population by 3 percentage points. Modeled exploitation rates for the five other populations with RERs range from 8 to 25 percentage points less than their RER ceilings. Escapements under Alternative 2, Scenario B, are predicted to exceed the CET for all populations except the North Fork Nooksack and South Fork Stillaguamish populations. In all but five cases (South Fork Nooksack, Skykomish, Sammamish, Cedar and Dungeness populations), escapements are predicted to exceed critical thresholds by more than 100 percent. Escapement under Alternative 2, Scenario B is predicted to meet or exceed VET for 9 of the 18 populations and one management unit for which VETs have been established, including: the Lower Sauk River, Upper Skagit River, Upper Sauk River, Suiattle River, White River, North Fork Stillaguamish, Green-Duwamish, Puyallup River and Nisqually River populations. Modeling results indicate that viable escapement thresholds would not be met for the 10 other populations and one management unit with Alternative 2, Scenario B (see Table 4.3-3 and Table 4.3-8b in Subsection 4.3.1.5).

For the Nooksack early management unit, model results indicate that the RER would be exceeded even without salmon fishing in Southern U.S. waters. For the Nooksack early chinook management unit, the probability of falling below its CET due to Southern U.S. fishing-related mortality is predicted to increase by 1 percentage point, and the probability of rebuilding is predicted to decrease by 1 percentage point, measured over 25 years.

Relative to Alternative 1, Scenario B, implementing Alternative 2, Scenario B, is predicted to result in low to moderate reductions in exploitation rates for nine Puget Sound chinook populations and one management unit, with resulting increases in spawning escapement. Impacts to these populations would be classed as beneficial and of low to moderate magnitude. Under Alternative 2, Scenario B, chinook salmon spawning escapements are predicted to decrease in the North and South Forks of the Stillaguamish, the Skykomish and Snoqualmie Rivers, and in the Puyallup, White and Nisqually Rivers. Impacts are predicted to be substantially negative for the North Fork Stillaguamish, the South Fork Stillaguamish, the Puyallup and the White River populations. Impacts to populations in the Skykomish, Snoqualmie and Nisqually Rivers are predicted to be negative but low. For the South Fork Stillaguamish population, the decreased escapements are predicted to be approximately 32 percent below the VET. Despite the predicted decrease in spawning escapement in the Puyallup, White, and Nisqually Rivers, these populations are all expected to meet or exceed VETs under Alternative 2, Scenario B. Escapements for the Green, Sammamish, Cedar, and Skokomish River populations are predicted to change by less than 1 percent relative to Alternative 1, Scenario B. These impacts are considered immeasurable. The pattern of impacts from applying Alternative 2 under Scenarios A, C, or D is predicted to be similar to its application under Alternative 2, Scenario B. In most cases, the type of impact (beneficial or negative) under Alternative 2, Scenario B, would be the same under Scenarios A, C, or D. However, as can be seen from Table 4.3-6 in Subsection 4.3.1.5, there is a tendency for the magnitude of beneficial impacts to increase and negative impacts to decrease going from Scenario B to Scenarios C or D. See Tables 4.3-8a-1 and 4.3-8d-2 in Subsection 4.3.1.5 for additional detail.

In summary, because Alternative 2 represents a more restrictive fishing regime than Alternative 1 (especially for populations in North Puget Sound), escapements are predicted to be higher for most populations compared to Alternative 1, Scenario B (see Tables 4.3-4 through 4.3-6 in Subsection 4.3.1.5). The notable exceptions are predicted to be escapements to the North and South Fork Stillaguamish, the Skykomish, and Snoqualmie populations where exploitation rates are predicted to be higher and escapements lower than under Alternative 1, Scenario B. The increased exploitation would result from the additional harvest opportunity available in Tulalip Bay (Marine Catch Area 8D) and the Stillaguamish River under Alternative 2 that is not anticipated to occur under Alternative 1.

The TRT has identified five distinct geographic/life history regions in the Puget Sound Chinook Salmon Evolutionarily Significant Unit: the Strait of Georgia, North Puget Sound, South Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Current TRT guidance recommends that a recovered ESU would have two to four low-risk populations within each region, representative of the range of life histories within each of the regions. Under Alternative 2, the Nooksack early management unit that makes up the Strait of Georgia region is predicted to exceed its RER; six of the eight[x] North Puget Sound populations are predicted to meet their RER and/or exceed the VETs; four of the six South Puget Sound populations are predicted to exceed their VETs; and none of the populations in the Strait of Georgia, Hood Canal, or the Strait of Juan de Fuca regions are predicted to exceed their VETs. Except for the North Fork Nooksack (Strait of Georgia) and South Fork Stillaguamish (North Puget Sound) chinook populations, all populations in all regions are predicted to exceed their CETs.

**Impacts to Hood Canal and Strait of Juan de Fuca Summer Chum Salmon**

Because virtually all marine salmon fisheries would be closed under Alternative 2, incidental impacts to summer chum predicted to occur under Alternative 1 would be eliminated, and the Southern U.S. catch of Hood Canal and Strait of Juan de Fuca summer chum salmon is predicted to be zero. Consequently, the exploitation rate is predicted to decrease to less than 1 percent (including Canadian fishery impacts), and escapement increase by approximately ~~76~~ 3 percent. The exploitation rate standards – 10.9 percent for populations in the Hood Canal region, and 9 percent for populations in the Strait of Juan de Fuca region – are predicted to be achieved. The changes in exploitation rate and escapement would be classified as ~~a substantial~~ low, beneficial effect for Hood Canal summer chum. The impact on Strait of Juan de Fuca summer chum is expected to be immeasurable. Impacts under Alternative 2, Scenarios A, C, and D were the same as under Alternative 2, Scenario B (see Tables 4.3-8a and 4.3.8b in Subsection 4.3.1.5).

#### 4.3.1.3 Alternative 3 – Escapement Goal Management at the Population Level

Alternative 3 represents a more restrictive fishing regime than Alternative 1 or Alternative 2, especially for populations in North Puget Sound. Escapements in North Puget Sound watersheds are predicted to be higher under Alternative 3 compared to Alternative 1. For all but two South Puget Sound chinook salmon populations (Puyallup River and White River), changes relative to Alterative 1 are predicted to be minimal.

**Summary of Scenario Differences**

Under Alternative 3, Scenarios A, C, or D, representing conditions similar to 2003 (A); decreased forecast abundance (C); or decreased forecast abundance with maximized Canadian/Alaskan fisheries

[x] There are ten populations in the North Puget Sound Region, but only eight currently have identified management standards.

(D), Southern U.S. catch of naturally-spawning Puget Sound chinook salmon is predicted to be 107 percent, 53 percent, and 49 percent, respectively, of that under Alternative 3, Scenario B. Catch of other species is discussed in Subsection 4.3.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis.

It is predicted that critical escapement thresholds would be met for all populations except the North Fork Nooksack chinook population under Alternative 3, Scenario A. Under Alternative 3, Scenarios C or D, it is predicted that CETs would be met for all populations except the Nooksack early chinook population. With the exception of the Lower Sauk population (20 to 25% below VET under Scenarios C or D), it is predicted that VETs would be met for the same populations under Alternative 3, Scenarios A, C, or D as they were under Alternative 3, Scenario B (see Table 4.3-5 and Tables 4.3-9a through 4.3-9d in Subsection 4.3.1.5).

**<u>Comparison of Alternative 3 to Alternative 1 (Proposed Action)</u>**

<u>Impacts to Puget Sound Chinook Populations</u>

Under Alternative 3, Scenario B (high abundance and Canadian/Alaskan fisheries at the maximum allowed by treaty), the Southern U.S. catch of chinook salmon from naturally-spawning Puget Sound populations is predicted to be 39,231, or 6,018 fewer than with Alternative 1, Scenario B. An additional 30,201 chinook salmon from hatcheries and from streams outside the action area are predicted to be landed, which is 81,730 fewer than with Alternative 1, Scenario B. The catch of listed Hood Canal/Strait of Juan de Fuca summer chum <u>(excluding those from the Quilcene/Dabob Bay Management Unit)</u> is predicted to be zero, or ~~1,663~~ <u>214</u> fewer than with Alternative 1, Scenario B. Catch of other species is discussed in Subsection 4.3.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis. See Table 4.3-9a through 4.3-9d in Subsection 4.3.1.5 for a detailed listing of fishery-related impacts to individual populations of Puget Sound chinook~~ and Hood Canal summer chum salmon~~.

Under Alternative 3, Scenario B, RERs are predicted to be met except for the Nooksack early chinook management unit and the Green River chinook population, and in these cases, exploitation rates are predicted to exceed the RER ceilings by 7 percentage points and 3 percentage points, respectively. As with Alternative 2, it should be noted that the Southern U.S. exploitation rate for the Nooksack early management unit is predicted to be only 1 percent while the total exploitation rate is predicted to be 19 percent. For the other populations in this group, predicted exploitation rates range from 8 to 25 percentage points below the RER ceilings. Critical escapement thresholds are predicted to be exceeded for all populations except the North Fork Nooksack population, in most cases by margins well over 100 percent. Escapements are predicted to exceed VETs for ten populations. Notably, the VET for the South Fork Stillaguamish population is predicted to be met with Alternative 3, Scenario B, whereas it is not under Alternative 2, Scenario B. Those populations that are not predicted to exceed VETs under Alternative 3, Scenario B, include Nooksack early, Lower Skagit, Skykomish, Dungeness, Elwha, Sammamish, Cedar, Mid-Hood Canal, and Skokomish chinook salmon populations (see Table 4.3-5 and Tables 4.3-9a-1 through 4.3-9d-2 in Subsection 4.3.1.5).

For the Nooksack early management unit, model results predict that the RER would be exceeded even without salmon fishing in Southern U.S. waters. For the Nooksack early chinook management unit, the probability of falling below its CET due to Southern U.S. fishing-related mortality is predicted to increase by 1 percentage point, and the probability of rebuilding is predicted to decrease by 1 percentage point, measured over 25 years.

Because Alternative 3 is very similar to Alternative 2, the impacts of its implementation relative to Alternative 1 would be nearly identical to those described for Alternative 2 (see Tables 4.3-3 and 4.3-4 in Subsection 4.3.1.5). The notable exception would be in the Stillaguamish watershed, where application of Alternative 3 is predicted to result in a small reduction in exploitation rate and low beneficial impacts to spawning escapement for populations within the Stillaguamish and Snohomish management units. Under Alternative 3, the South Fork Stillaguamish population is predicted to meet its CET under all scenarios, whereas it is not predicted to meet its CET under Alternative 2 for any scenario. Relative to Alternative 1, Scenario B, impacts associated with the application of Alternative 3, Scenario B, would be beneficial and of low to moderate impact for 14 populations, substantially negative for two populations (Puyallup and White River), and of a low negative magnitude for one population (Nisqually River). Model results of the effects of Alternative 3 on the Green, Sammamish, and Cedar River chinook salmon populations were less than 1 percent and therefore classed as immeasurable. For Scenarios A, C, or D, predicted impacts (relative to Alternative 1 Scenarios A, C, or D) would be nearly identical to those under Scenario B. Although small changes in escapement (Cedar, Sammamish and Skokomish populations) shifted impacts from low negative, to low beneficial, or no to low impact in some cases, the actual percentage changes were very small (see Table 4.3-4, Table 4.3-6, and Tables 4.3-9a-2 through 4.3-9d-2 in Subsection 4.3.1.5).

In summary, Alternative 3 represents a more restrictive fishing regime than Alternative 1 or Alternative 2, especially for populations in North Puget Sound; therefore, it is predicted that escapements in North Puget Sound watersheds would be higher compared to Alternative 1. For all but two South Puget

Sound populations (Puyallup River and White River), changes relative to Alterative 1 are predicted to be minimal (see Tables 4.3-4 and 4.3-5 in Subsection 4.3.1.5).

The TRT has identified five distinct geographic/life history regions in the Puget Sound Chinook Salmon ESU: the Strait of Georgia, North Puget Sound, South Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Current TRT guidance recommends that a recovered ESU would have two to four low-risk populations within each region, representative of the range of life histories within each of the regions. Under Alternative 3, the Nooksack early management unit that makes up the Strait of Georgia region is predicted to exceed its RER; all eight [xi] North Puget Sound populations are predicted to meet their RER and/or exceed the VETs; four of the six South Puget Sound populations are predicted to exceed their VETs; and none of the populations in the Strait of Georgia Strait, Hood Canal, or the Strait of Juan de Fuca regions are predicted to exceed their VETs. Except for the North Fork Nooksack chinook population, all populations in all regions are predicted to exceed their CETs.

Impacts to Hood Canal and Strait of Juan de Fuca Summer Chum

The catch of listed Hood Canal/Strait of Juan de Fuca summer chum (excluding those from the Quilcene/Dabob Bay Management Unit) is predicted to be zero, or 214 fewer than with Alternative 1, Scenario B. Under Alternative 3, there would be no summer chum harvested in Puget Sound fisheries. Therefore, the consequences would be the same as those described for Alternative 2. See Table 4.3-9a through 4.3-9d in Subsection 4.3.1.5 for a detailed listing of fishery-related impacts to individual populations of Puget Sound chinook and Hood Canal summer chum salmon.

#### 4.3.1.4 Alternative 4 – No Action/No Authorized Take

Alternative 4, the most restrictive of the harvest management alternatives, is predicted to reduce catch and increase escapement of all populations of naturally-spawning Puget Sound chinook salmon relative to Alternative 1.

**Summary or Scenario Differences**

Under Alternative 4, Scenarios A, C, or D, representing conditions similar to 2003 (A); decreased forecast abundance (C); or decreased forecast abundance with maximized Canadian/Alaskan fisheries (D), Southern U.S. catch of naturally-spawning chinook is predicted to be 99 percent, 73 percent, and

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[xi] There are ten populations in the North Puget Sound Region, but only eight currently have identified management standards.

73 percent, respectively, of that with Alternative 3, Scenario B. Catch of other species is discussed in Subsection 4.3.2, Basis of Comparison of Alternatives and Approach to Alternatives Analysis.

Modeled escapement patterns under Alternative 4, Scenarios A, C, or D were similar to those under Alternative 4, Scenario B. Decreased abundance under Scenarios C or D would result in predicted escapement for the Nooksack early populations falling below their CETs under Scenarios C or D, whereas escapement was above CET for Scenarios A or B for the North Fork Nooksack population. Decreased abundance under Scenarios C or D would result in predicted escapement for the Lower Skagit population falling below its VET in Scenarios C or D, whereas it exceeded VET in Scenarios A and B (see Table 4.3-5 and Tables 4.3-10a-1 through 4.3-10d-1in Subsection 4.3.1.5).

**<u>Comparison of Alternative 4 to Alternative 1 (Proposed Action)</u>**

<u>Impacts to Puget Sound Chinook Populations</u>

Under Alternative 4, Scenario B (high abundance and Canadian/Alaskan fisheries at the maximum allowed by treaty), the catch of Puget Sound chinook from naturally-spawning chinook populations is predicted to be 6,289 fish, or 46,648 fewer than with Alternative 1, Scenario B. The total chinook catch predicted under Alternative 4, Scenario B, is 150,891 fewer than with Alternative 1, Scenario B (see Table 4.3-2 in Subsection 4.3.1.5).

Catch of other species is discussed in Subsection 4.3.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis. See Tables 4.3-10a through 4.3-10d~~b~~ in Subsection 4.3.1.5 for a detailed listing of fishery-related impacts to individual populations of Puget Sound chinook and Hood Canal summer chum salmon.

Population-specific impacts of Alternative 4 under Scenario B, are predicted to be nearly identical to those of Alternative 2 or 3, Scenario B. Under Alternative 4, Scenario B, exploitation rates are predicted to be less than RER standards for all populations except in the Nooksack early management unit. Critical escapement thresholds are predicted to be exceeded for all populations except the North Fork Nooksack population.Viable escapement thresholds are predicted to be met or exceeded for the Lower Sauk, Upper Skagit, North Fork Stillaguamish, Upper Sauk, Suiattle, White River, the South Fork Stillaguamish, Green-Duwamish, Puyallup, Nisqually, and Skokomish chinook salmon populations (see Table 4.3-3 and Table 4.3-10b in Subsection 4.3.1.5).

For the Nooksack early management unit, the RER would be exceeded even without salmon fishing in Southern U.S. waters. For the Nooksack early chinook management unit, the probability of falling below its CET due to Southern U.S. fishing-related mortality is predicted to increase by 1 percentage point and the probability of rebuilding is predicted to decrease by 1 percentage point, measured over 25 years.

Alternative 4, the most restrictive of the alternatives, is predicted to reduce catch and increase escapement of all populations of naturally-spawning Puget Sound chinook salmon relative to Alternative 1. Increases in escapement are predicted to result in beneficial impacts of low to moderate magnitude for 16 of the 22 populations, and substantial beneficial impacts for four other populations. The four populations predicted to have substantial increases in spawning escapement under Alternative 4 relative to Alternative 1 are the Green, Puyallup, Nisqually, and Skokomish chinook salmon populations. Modeled spawning escapements for these populations predict exceedance of the VET by 84 percent, 163 percent, 196 percent, and 90 percent, respectively (see Table 4.3-4 and Table 4.3-10a-2 in Subsection 4.3.1.5). However, to some extent, the beneficial impact of increased escapement might be moderated by capacity of the extant habitats to support additional spawners and their progeny.

As would be expected, impacts associated with the application of Alternative 4 under Scenarios A, C, or D relative to Alternative 1, Scenarios A, C, or D, were similar in type and, in most cases, magnitude, to the impacts modeled under Scenario B. Two notable exceptions were the Green River and Puyallup River populations where substantial beneficial impacts were indicated under Scenarios A or B, but only moderately beneficial impacts under Scenarios C or D (lower abundance conditions). For the Cedar and Sammamish River populations, impacts are predicted to range from low and beneficial (Alternative 4, Scenario A or B) to low and adverse (Alternative 4, Scenarios C or D), compared to the same scenarios under Alternative 1. However, the actual change in numbers of fish in escapement is predicted to be no more than 1 percent (see Table 4.3-4 and Tables 4.3-10a-2 through 4.3-10d-2 in Subsection 4.3.1.5).

In summary, Alternative 4 represents the most restrictive fishing regime and would result in low to substantial increases in spawning escapement relative to Alternative 1. These increases would not necessarily result in beneficial impacts to all populations. (See discussion below.)

The TRT has identified five distinct geographic/life history regions in the Puget Sound Chinook Salmon ESU: the Strait of Georgia, North Puget Sound, South Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Current TRT guidance recommends that a recovered ESU would have two to four low-risk populations within each region, representative of the range of life histories within each of the regions. Under Alternative 4, the Nooksack early populations that make up the Strait of Georgia region are predicted to exceed its RER; all eight[xii] North Puget Sound populations are predicted to meet their RER and/or exceed the VETs; four of the six South Puget Sound populations are predicted to exceed their VETs; one of the two populations in the Hood Canal region is predicted to exceed its VET; and none of the populations in the Strait of Georgia or the Strait of Juan de Fuca regions are predicted to exceed their VETs. Except for the North Fork Nooksack chinook population, all populations in all regions are predicted to exceed their CETs.

Impacts to Hood Canal and Strait of Juan de Fuca Summer Chum

Under Alternative 4, the catch from listed Hood Canal and Strait of Juan de Fuca summer chum salmon populations is predicted to be zero, compared to 214 and 12, respectively,~~141~~ under Alternative 1. Therefore, the consequences would be the same as those described for Alternative 2 or 3.

#### 4.3.1.5 Summary Discussion of Alternatives

Under Alternative 1, the Proposed Action, RERs are predicted to be met under nearly all scenarios and within nearly all populations except the Nooksack early chinook management unit, and the Skykomish summer population. While the Skykomish summer population is predicted to meet the RER standard under most other alternatives and scenarios, the Nooksack early management unit is not predicted to meet its RER goal under any alternative or scenario. Failure of the Nooksack early populations to meet RERs and, in most instances, CETs, can be attributed to the fact that a high proportion of impacts to this population occur in fisheries outside of Puget Sound, not within the jurisdiction of the Resource Management Plan. Another notable exception is predicted for the Green River population. However, unlike the Nooksack population, the Green River population, despite exceeding RER ceilings under several alternative/scenario combinations, is predicted to meet or exceed its VET in all cases.

Critical escapement goals are predicted to be met for all populations under Alternative 1 except the North Fork Nooksack chinook salmon population, the South Fork Nooksack population under the lower abundance scenarios, and the South Fork Stillaguamish fall population under any scenario. The North Fork Nooksack population is not predicted to meet its CET under any alternative or scenario. Seventy percent or more of the fishing-related mortality on the Nooksack early chinook population occurs as a result of Canadian/Alaskan fisheries. Catch in fisheries covered by the Resource

[xii] There are ten populations in the North Puget Sound Region, but only eight currently have identified management standards.

Management Plan is predicted to be at most 36 fish; thus, there is likely to be little difference in the impact of any alternative.

Under Alternative 1, performance relative to VETs is predicted to vary considerably for the different populations. What would be consistent, however, is that certain populations are predicted to not meet VETs under most, if not all alternatives and scenarios. These include the Nooksack early, Lower Skagit, Skykomish, Sammamish, Cedar, Mid-Hood Canal, Skokomish, Dungeness, and Elwha River populations.

As noted previously, increasingly restrictive alternatives generally result in increased spawning escapement. Thus, application of Alternatives 2 through 4 appear to have a beneficial impact on most populations relative to Alternative 1. However, while spawning escapement provides a useful basis for comparing alternatives, the intricacy of salmon life histories must be taken into account in interpreting the model results.

First, substantial increases in spawning escapements may not result in commensurate increases in the progeny of those chinook salmon spawners. The objective for salmon fisheries management is to constrain fishing mortality to the extent necessary to optimize the production of subsequent generations. The productivity of salmon populations, often defined in terms of the number of recruits produced per female spawner, increases over a range of escapement, then reaches a plateau or declines at higher levels of escapement due to density-dependent survival; i.e., too many spawners for the available habitat, or too many juvenile salmon for the available food in the river. The escapement level corresponding to the point of optimum productivity varies widely among individual populations due to the accessible area of suitable spawning and rearing habitat within a river system, and the very complex array of physical and biological factors that influence the annual survival of salmon eggs and juveniles through their freshwater life history. However, the influence of these physical and biological factors varies greatly from year to year, so that were fisheries management to achieve optimum escapement consistently from year to year, the actual production from those spawners would still vary widely. The marine environment exerts even greater influence on the number of juvenile salmon that reach adulthood. Consequently, this Environmental Impact Statement can compare the predicted escapement for populations against specific or general escapement standards, but cannot accurately project the resulting abundance of subsequent generations of adult salmon. In addition, changes in risk relative to achievement of the RERs may not be the same as changes in risk measured by changes in escapement. That is, the changes in achieving the RERs are likely to be more beneficial or adverse relative to recovery than changes in escapement.

The harvest standards for the Hood Canal and Strait of Juan de Fuca Summer Chum Evolutionarily Significant Unit are predicted to be met under any alternative.

Table 4.3-2. Predicted Southern U.S. catch of Puget Sound chinook populations under Alternatives 1-4 and Scenarios A-D.

| | | Scenario A | Scenario B | Scenario C | Scenario D |
|---|---|---|---|---|---|
| Natural | | 55,512 | 45,249 | 32,256 | 31,238 |
| Other | Alternative 1 | 110,994 | 111,931 | 83,808 | 81,058 |
| Total | | 166,506 | 157,180 | 116,064 | 112,296 |
| Natural | | 45,249 | 42,793 | 21,614 | 19,667 |
| Other | Alternative 2 | 81,570 | 36,074 | 21,753 | 19,354 |
| Total | | 126,819 | 78,867 | 43,367 | 39,021 |
| Natural | | 41,931 | 39,231 | 20,785 | 18,885 |
| Other | Alternative 3 | 65,565 | 30,201 | 21,753 | 19,354 |
| Total | | 107,496 | 69,432 | 42,538 | 38,239 |
| Natural | | 6,233 | 6,289 | 4,597 | 4,619 |
| Other | Alternative 4 | | | | |
| Total | | 6,233 | 6,289 | 4,597 | 4,619 |

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-3. Performance of Alternatives 1 through 4 under Scenario B relative to rebuilding exploitation rate, critical escapement threshold, and viable escapement threshold standards.

| | Performance Relative to Rebuilding Exploitation Rate | | | | Performance Relative to Critical Escapement Threshold | | | | Performance Relative to Viable Escapement Threshold | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A-1 | A-2 | A-3 | A-4 | A-1 | A-2 | A-3 | A-4 | A-1 | A-2 | A-3 | A-4 |
| Nooksack Early* | N | N | N | N | | | | | N | N | N | N |
| North Fork | | | | | N | N | N | N | NA | NA | NA | NA |
| South Fork | | | | | Y | Y | Y | Y | NA | NA | NA | NA |
| Skagit Summer-Fall* | | | | | | | | | | | | |
| Lower Skagit Fall | N | Y | Y | Y | Y | Y | Y | Y | N | N | N | N |
| Lower Sauk Summer | N | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y |
| Upper Skagit Summer | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Skagit Spring* | | | | | | | | | | | | |
| Upper Cascade | NA | NA | NA | NA | Y | Y | Y | Y | | | | |
| Upper Sauk | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Suiattle | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Stillaguamish Summer-Fall* | | | | | | | | | | | | |
| North Fork Summer | Y | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| South Fork Fall | Y | N | Y | Y | Y | N | Y | Y | Y | N | Y | Y |
| Snohomish Summer-Fall* | | | | | | | | | | | | |
| Skykomish Summer | N | N | Y | Y | Y | Y | Y | Y | N | N | N | N |
| Snoqualmie Fall | NA | NA | NA | NA | Y | Y | Y | Y | NA | NA | NA | NA |
| Green-Duwamish Fall* | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Lake Washington Fall | | | | | | | | | | | | |
| Sammamish | NA | NA | NA | NA | Y | Y | Y | Y | N | N | N | N |
| Cedar | NA | NA | NA | NA | Y | Y | Y | Y | N | N | N | N |
| Puyallup Fall | NA | NA | NA | NA | Y | Y | Y | Y | Y | Y | Y | Y |
| White River Spring | NA | NA | NA | NA | Y | Y | Y | Y | Y | Y | Y | Y |
| Nisqually Fall | NA | NA | NA | NA | Y | Y | Y | Y | Y | Y | Y | Y |
| Mid- Hood Canal Fall | NA | NA | NA | NA | Y | Y | Y | Y | N | N | N | N |
| Skokomish Fall | NA | NA | NA | NA | Y | Y | Y | Y | N | N | N | Y |
| Dungeness Summer | NA | NA | NA | NA | Y | Y | Y | Y | N | N | N | N |
| Elwha Summer | NA | NA | NA | NA | Y | Y | Y | Y | N | N | N | N |

Y Meets or exceeds goal.
N Does not meet goal.
NA Standard not applicable.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-4 Summary of impacts of Alternatives 2-4 relative to the proposed action under Scenario B

| | Alternative 2 Compared to Alternative 1 | | Alternative 3 Compared to Alternative 1 | | Alternative 4 Compared to Alternative 1 | |
|---|---|---|---|---|---|---|
| | Type | Extent | Type | Extent | Type | Extent |
| Nooksack Early | B | M | B | M | B | M |
| Lower Skagit Fall | B | M | B | M | B | M |
| Lower Sauk Summer | B | M | B | M | B | M |
| Upper Skagit Summer | B | M | B | M | B | M |
| Upper Cascade Spring | B | L | B | L | B | L |
| Upper Sauk Spring | B | L | B | L | B | L |
| Suiattle Spring | B | L | B | L | B | L |
| NF Stillaguamish Summer | N | S | B | L | B | L |
| SF Stillaguamish Fall | N | S | B | L | B | L |
| Skykomish Summer | N | L | B | M | B | M |
| Snoqualmie Fall | N | L | B | M | B | M |
| Green-Duwamish Fall | 0 | 0 | 0 | 0 | B | S |
| Sammamish Fall | 0 | 0 | 0 | 0 | 0 | 0 |
| Cedar Fall | 0 | 0 | 0 | 0 | 0 | 0 |
| Puyallup Fall | N | S | N | S | B | S |
| White River Spring | N | S | N | S | B | M |
| Nisqually Fall | N | L | N | L | B | S |
| Mid-Hood Canal Fall | B | L | B | L | B | L |
| Skokomish Fall | 0 | 0 | 0 | 0 | B | S |
| Dungeness Summer | B | L | B | L | B | L |
| Elwha Summer | B | L | B | L | B | L |

| Impact Type | | Impact Magnitude | |
|---|---|---|---|
| Beneficial | B | Low (<10%) | L |
| Negative | N | Moderate (10%-30%) | M |
| None (not measurable) | 0 | Substantial (>30%) | S |
| | | Not Measurable (<1%) | 0 |

Table 4.3-5. Performance of Alternatives 1 through 4 under Scenarios A-D relative to rebuilding exploitation rate, critical escapement threshold, and viable escapement threshold standards.

**Rebuilding Exploitation Rate**

| | Alternative 1 | | | | Alternative 2 | | | | Alternative 3 | | | | Alternative 4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S-A | S-B | S-C | S-D | S-A | S-B | S-C | S-D | S-A | S-B | S-C | S-D | S-A | S-B | S-C | S-D |
| Nooksack Early* | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| North Fork | | | | | | | | | | | | | | | | |
| South Fork | | | | | | | | | | | | | | | | |
| Skagit Summer-Fall* | | | | | | | | | | | | | | | | |
| Lower Skagit Fall | Y | N | Y | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Lower Sauk Summer | Y | N | Y | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Upper Skagit Summer | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Skagit Spring* | | | | | | | | | | | | | | | | |
| Upper Cascade | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Upper Sauk | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Suiattle | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Stillaguamish Summer-Fall* | | | | | | | | | | | | | | | | |
| North Fork Summer | Y | Y | Y | Y | N | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y |
| South Fork Fall | Y | Y | Y | Y | N | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y |
| Snohomish Summer-Fall* | | | | | | | | | | | | | | | | |
| Skykomish Summer | Y | Y | Y | Y | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Snoqualmie Fall | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Green-Duwamish Fall* | Y | Y | Y | Y | N | N | Y | Y | N | N | Y | Y | Y | Y | Y | Y |
| Lake Washington Fall | | | | | | | | | | | | | | | | |
| Sammamish | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Cedar | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Puyallup Fall | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| White River Spring | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Nisqually Fall | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mid- Hood Canal Fall | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Skokomish Fall | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Dungeness Summer | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Elwha Summer | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**Critical Escapement Threhold**

| | Alternative 1 | | | | Alternative 2 | | | | Alternative 3 | | | | Alternative 4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S-A | S-B | S-C | S-D | S-A | S-B | S-C | S-D | S-A | S-B | S-C | S-D | S-A | S-B | S-C | S-D |
| Nooksack Early* | | | | | | | | | | | | | | | | |
| North Fork | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| South Fork | Y | Y | N | N | Y | Y | N | N | Y | Y | N | N | Y | Y | N | N |
| Skagit Summer-Fall* | | | | | | | | | | | | | | | | |
| Lower Skagit Fall | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Lower Sauk Summer | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Upper Skagit Summer | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Skagit Spring* | | | | | | | | | | | | | | | | |
| Upper Cascade | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Upper Sauk | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Suiattle | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Stillaguamish Summer-Fall* | | | | | | | | | | | | | | | | |
| North Fork Summer | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| South Fork Fall | Y | Y | Y | Y | N | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y |
| Snohomish Summer-Fall* | | | | | | | | | | | | | | | | |
| Skykomish Summer | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Snoqualmie Fall | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Green-Duwamish Fall* | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Lake Washington Fall | | | | | | | | | | | | | | | | |
| Sammamish | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Cedar | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Puyallup Fall | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| White River Spring | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Nisqually Fall | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Mid- Hood Canal Fall | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Skokomish Fall | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Dungeness Summer | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Elwha Summer | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |

**Viable Escapement Threhold**

| | Alternative 1 | | | | Alternative 2 | | | | Alternative 3 | | | | Alternative 4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S-A | S-B | S-C | S-D | S-A | S-B | S-C | S-D | S-A | S-B | S-C | S-D | S-A | S-B | S-C | S-D |
| Nooksack Early* | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| North Fork | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| South Fork | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Skagit Summer-Fall* | | | | | | | | | | | | | | | | |
| Lower Skagit Fall | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Lower Sauk Summer | N | N | N | N | Y | Y | N | N | Y | Y | N | N | Y | Y | N | N |
| Upper Skagit Summer | Y | Y | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Skagit Spring* | | | | | | | | | | | | | | | | |
| Upper Cascade | | | | | | | | | | | | | | | | |
| Upper Sauk | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Suiattle | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Stillaguamish Summer-Fall* | | | | | | | | | | | | | | | | |
| North Fork Summer | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| South Fork Fall | Y | Y | N | N | N | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y |
| Snohomish Summer-Fall* | | | | | | | | | | | | | | | | |
| Skykomish Summer | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Snoqualmie Fall | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Green-Duwamish Fall* | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Lake Washington Fall | | | | | | | | | | | | | | | | |
| Sammamish | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Cedar | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Puyallup Fall | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| White River Spring | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Nisqually Fall | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Mid- Hood Canal Fall | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Skokomish Fall | N | N | N | N | N | N | N | N | N | N | N | N | Y | Y | Y | Y |
| Dungeness Summer | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Elwha Summer | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |

Y Meets or exceeds goal.
N Does not meet goal.
NA Standard not applicable.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-6 Summary of impacts of alternatives 2-4 relative to the proposed action under scenarios 1-4.

| | Alternative 2 Compared to Alternative 1 | | | | | | | | Alternative 3 Compared to Alternative 1 | | | | | | | | Alternative 4 Compared to Alternative 1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scenario A | | Scenario B | | Scenario C | | Scenario D | | Scenario A | | Scenario B | | Scenario C | | Scenario D | | Scenario A | | Scenario B | | Scenario C | | Scenario D | |
| | Type | Extent | Type | Extent | Type | Extent | Type | Extent | Type | Extent | Type | Extent | Type | Extent | Type | Extent | Type | Extent | Type | Extent | Type | Extent | Type | Extent |
| Nooksack Early | B | L | B | M | B | L | B | M | B | L | B | M | B | L | B | M | B | L | B | M | B | L | B | M |
| Lower Skagit Fall | B | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M |
| Lower Sauk Summer | B | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M |
| Upper Skagit Summer | B | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M |
| Upper Cascade Spring | B | L | B | L | B | M | B | M | B | L | B | L | B | M | B | M | B | L | B | L | B | M | B | M |
| Upper Sauk Spring | B | L | B | L | B | M | B | M | B | L | B | L | B | M | B | M | B | L | B | L | B | M | B | M |
| Suiattle Spring | B | L | B | L | B | M | B | M | B | L | B | L | B | M | B | M | B | L | B | L | B | M | B | M |
| NF Stillaguamish Summer | N | S | N | S | N | S | N | S | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L |
| SF Stillaguamish Fall | N | S | N | S | N | S | N | S | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L |
| Skykomish Summer | N | L | N | L | B | L | B | L | B | L | B | M | B | L | B | L | B | L | B | M | B | L | B | L |
| Snoqualmie Fall | N | L | N | L | B | L | B | L | B | L | B | M | B | L | B | L | B | L | B | M | B | L | B | L |
| Green-Duwamish Fall | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | B | S | B | S | B | M | B | M |
| Sammamish Fall | B | L | 0 | 0 | N | L | N | L | B | L | 0 | 0 | N | L | N | L | B | L | 0 | 0 | N | L | N | L |
| Cedar Fall | B | L | 0 | 0 | N | L | N | L | B | L | 0 | 0 | N | L | N | L | B | L | 0 | 0 | N | L | N | L |
| Puyallup Fall | N | S | N | S | N | S | N | S | N | S | N | S | N | S | N | S | B | S | B | S | B | M | B | M |
| White River Spring | N | S | N | S | N | L | N | L | N | S | N | S | N | L | N | L | B | M | B | M | B | M | B | M |
| Nisqually Fall | N | L | N | L | N | L | N | L | N | L | N | L | N | L | N | L | B | S | B | S | B | S | B | S |
| Mid-Hood Canal Fall | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L |
| Skokomish Fall | B | L | 0 | 0 | N | L | N | L | B | L | 0 | 0 | N | L | N | L | B | S | B | S | B | S | B | S |
| Dungeness Summer | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L |
| Elwha Summer | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L | B | L |

Impact Type

| | |
|---|---|
| Beneficial | B |
| Negative | N |
| Not Measurable | 0 |

Impact Extent

| | |
|---|---|
| Low (<10%) | L |
| Moderate (10%-30%) | M |
| Substantial (>30%) | S |
| Not Measurable (<1%) | 0 |

Table 4.3-7a Performance of Alternative 1 (Proposed Action) under Scenario A relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

| **Puget Sound Chinook** | **Alternative 1 Scenario A** | | | | **Performance vs. Recovery Standards** | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S. Wild Exploitation Rate | Southern U.S.Catch | Natural Escapement | Rebuilding Exploitation Rate[1] | Critical Escapement Threshold[2] | Viable Escapement or Escapement Goal[3] |
| Nooksack Early* | 20% | 7% | 37 | 388 | 8% | | -22% |
| North Fork | | | | 171 | | -15% | |
| South Fork | | | | 217 | | 9% | |
| Skagit Summer-Fall* | 48% | 18% | 3,894 | 11,633 | | | |
| Lower Skagit Fall | | | | 1,247 | -1% | 397% | -43% |
| Lower Sauk Summer | | | | 620 | -3% | 210% | -9% |
| Upper Skagit Summer | | | | 9,765 | -12% | 910% | 31% |
| Skagit Spring* | 23% | 23% | 570 | 1,921 | | | |
| Upper Cascade | | | | 563 | | 231% | |
| Upper Sauk | | | | 647 | -15% | 398% | 96% |
| Suiattle | | | | 712 | -18% | 319% | 78% |
| Stillaguamish Summer-F | 17% | 11% | 313 | 2,322 | | | |
| North Fork Summer | | | | 1,892 | -15% | 531% | 243% |
| South Fork Fall | | | | 430 | -7% | 115% | 43% |
| Snohomish Summer-Fal | 19% | 18% | 2,325 | 5,073 | | | |
| Skykomish Summer | | | | 2,604 | -18% | 58% | -26% |
| Snoqualmie Fall | | | | 2,469 | | 517% | |
| Green-Duwamish Fall* | 62% | 51% | 15,901 | 5,819 | 9% | 597% | 5% |
| Lake Washington Fall | | 20% | | | | | |
| Sammamish | 31% | | 86 | 305 | | 53% | -76% |
| Cedar | 31% | | 87 | 305 | | 53% | -75% |
| Puyallup Fall | 49% | 39% | 5,024 | 2,392 | | 1096% | 99% |
| White River Spring | 20% | 19% | 356 | 1,468 | | 634% | 47% |
| Nisqually Fall | 76% | 68% | 17,425 | 1,106 | | 453% | 1% |
| Mid- Hood Canal Fall | 26% | 13% | 95 | 531 | | 166% | -58% |
| Skokomish Fall | 63% | 50% | 9,372 | 1,211 | | 506% | -3% |
| Dungeness Summer | 22% | 5% | 15 | 352 | | 76% | -62% |
| Elwha Summer | 22% | 5% | 98 | 2,125 | | 963% | -27% |
| ***All Chinook from Listed Populations*** | | | **55,599** | **36,951** | | | |

| **Hood Canal and Strait of Juan de Fuca Summer Chum** | | | | **Performance vs Recovery Standards** | |
|---|---|---|---|---|---|
| | Wild Exploitation Rate [4] | Southern U.S. Catch [4] | Natural Escapement | Rebuilding Exploitation Rate | Critical Escapement Threshold |
| Hood Canal | 3% | 214 | 7,437 | -8% | 83% |
| Juan de Fuca | 0.4% | 12 | 6,955 | -9% | 656% |
| ***All Summer Chum*** | | **226** | **14,392** | | |

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

(grey shading) Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-7b Performance of Alternative 1 (Proposed Action) under Scenario B relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

| **Puget Sound Chinook** | **Alternative 1 Scenario B** | | | | **Performance vs. Recovery Standards** | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S. Wild Exploitation Rate | Southern U.S.Catch | Natural Escapement | Rebuilding Exploitation Rate[1] | Critical Escapement Threshold[2] | Viable Escapement or Escapement Goal[3] |
| Nooksack Early* | 25% | 8% | 38 | 365 | 13% | | -27% |
| North Fork | | | | 161 | | -20% | |
| South Fork | | | | 204 | | 2% | |
| Skagit Summer-Fall* | 55% | 16% | 3,737 | 11,029 | | | |
| Lower Skagit Fall | | | | 1,183 | 6% | 371% | -46% |
| Lower Sauk Summer | | | | 588 | 4% | 194% | -14% |
| Upper Skagit Summer | | | | 9,258 | -5% | 857% | 24% |
| Skagit Spring* | 27% | 23% | 567 | 1,845 | | | |
| Upper Cascade | | | | 541 | | 218% | |
| Upper Sauk | | | | 622 | -11% | 378% | 88% |
| Suiattle | | | | 684 | -14% | 302% | 71% |
| Stillaguamish Summer-F | 19% | 11% | 314 | 2,281 | | | |
| North Fork Summer | | | | 1,859 | -13% | 520% | 237% |
| South Fork Fall | | | | 422 | -5% | 111% | 41% |
| Snohomish Summer-Fal | 22% | 18% | 2,286 | 4,901 | | | |
| Skykomish Summer | | | | 2,516 | -18% | 52% | -28% |
| Snoqualmie Fall | | | | 2,385 | | 496% | |
| Green-Duwamish Fall* | 63% | 47% | 15,103 | 5,816 | 10% | 597% | 5% |
| Lake Washington Fall | | 20% | | | | | |
| Sammamish | 35% | | 86 | 294 | | 47% | -76% |
| Cedar | 35% | | 85 | 294 | | 47% | -76% |
| Puyallup Fall | 50% | 35% | 4,623 | 2,419 | | 1110% | 102% |
| White River Spring | 20% | 18% | 323 | 1,459 | | 630% | 46% |
| Nisqually Fall | 76% | 65% | 16,929 | 1,126 | | 463% | 2% |
| Mid- Hood Canal Fall | 32% | 13% | 94 | 504 | | 152% | -60% |
| Skokomish Fall | 63% | 44% | 8,509 | 1,237 | | 519% | -1% |
| Dungeness Summer | 27% | 5% | 15 | 336 | | 68% | -64% |
| Elwha Summer | 28% | 5% | 97 | 2,031 | | 916% | -30% |
| ***All Chinook from Listed Populations*** | | | **52,806** | **35,937** | | | |

| **Hood Canal and Strait of Juan de Fuca Summer Chum** | | | | **Performance vs Recovery Standards** | |
|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch[4] | Natural Escapement | Rebuilding Exploitation Rate | Critical Escapement Threshold |
| Hood Canal | 3% | 214 | 7,437 | -8% | 83% |
| Juan de Fuca | 0.4% | 12 | 6,955 | -9% | 656% |
| ***All Summer Chum*** | | **226** | **14,392** | | |

* Populations with specific NMFS-developed standards

1 Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

2 Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

3 Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

4 Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-7c Performance of Alternative 1 (Proposed Action) under Scenario C relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

| **Puget Sound Chinook** | **Alternative 1 Scenario C** | | | | **Performance vs. Recovery Standards** | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S. Wild Exploitation Rate | Southern U.S.Catch | Natural Escapement | Rebuilding Exploitation Rate[1] | Critical Escapement Threshold[2] | Viable Escapement or Escapement Goal[3] |
| Nooksack Early* | 20% | 7% | 26 | 278 | 8% | | -44% |
| North Fork | | | | 122 | | -39% | |
| South Fork | | | | 156 | | -22% | |
| Skagit Summer-Fall* | 49% | 18% | 2,778 | 8,033 | | | |
| Lower Skagit Fall | | | | 861 | 0% | 243% | -61% |
| Lower Sauk Summer | | | | 428 | -2% | 114% | -37% |
| Upper Skagit Summer | | | | 6,743 | -11% | 597% | -10% |
| Skagit Spring* | 23% | 23% | 393 | 1,331 | | | |
| Upper Cascade | | | | 390 | | 129% | |
| Upper Sauk | | | | 449 | -15% | 245% | 36% |
| Suiattle | | | | 493 | -18% | 190% | 23% |
| Stillaguamish Summer-F | 17% | 12% | 225 | 1,620 | | | |
| North Fork Summer | | | | 1,320 | -15% | 340% | 139% |
| South Fork Fall | | | | 300 | -7% | 50% | 0% |
| Snohomish Summer-Fal | 20% | 18% | 1,633 | 3,543 | | | |
| Skykomish Summer | | | | 1,819 | -18% | 10% | -48% |
| Snoqualmie Fall | | | | 1,724 | | 331% | |
| Green-Duwamish Fall* | 49% | 39% | 9,185 | 5,801 | -4% | 595% | 5% |
| Lake Washington Fall | | 23% | | | | | |
| Sammamish | 33% | | 72 | 223 | | 12% | -82% |
| Cedar | 33% | | 72 | 223 | | 12% | -81% |
| Puyallup Fall | 50% | 39% | 3,772 | 1,798 | | 799% | 50% |
| White River Spring | 20% | 19% | 243 | 1,011 | | 406% | 1% |
| Nisqually Fall | 64% | 56% | 9,544 | 1,119 | | 460% | 2% |
| Mid- Hood Canal Fall | 26% | 12% | 65 | 367 | | 84% | -71% |
| Skokomish Fall | 45% | 31% | 4,166 | 1,239 | | 520% | -1% |
| Dungeness Summer | 22% | 5% | 12 | 245 | | 23% | -74% |
| Elwha Summer | 23% | 5% | 70 | 1,480 | | 640% | -49% |
| ***All Chinook from Listed Populations*** | | | **32,256** | **28,311** | | | |

| **Hood Canal and Strait of Juan de Fuca Summer Chum** | | | | **Performance vs Recovery Standards** | |
|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch[4] | Natural Escapement | Rebuilding Exploitation Rate | Critical Escapement Threshold |
| Hood Canal | 3% | 214 | 7,437 | -8% | 83% |
| Juan de Fuca | 0.4% | 12 | 6,955 | -9% | 656% |
| ***All Summer Chum*** | | **226** | **14,392** | | |

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard. (shaded cells: Nooksack Early 8% and -44%; North Fork -39%; South Fork -22%; Lower Skagit Fall -61%; Lower Sauk Summer -37%; Upper Skagit Summer -10%; South Fork Fall 0%; Skykomish Summer -48%; Sammamish -82%; Cedar -81%; Mid- Hood Canal Fall -71%; Skokomish Fall -1%; Dungeness Summer -74%; Elwha Summer -49%)

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-7d Performance of Alternative 1 (Proposed Action) under Scenario D relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

| **Puget Sound Chinook** | **Alternative 1 Scenario D** | | | | **Performance vs. Recovery Standards** | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S. Wild Exploitation Rate | Southern U.S.Catch | Natural Escapement | Rebuilding Exploitation Rate[1] | Critical Escapement Threshold[2] | Viable Escapement or Escapement Goal[3] |
| Nooksack Early* | 26% | 7% | 27 | 252 | 14% | | -50% |
| North Fork | | | | 111 | | -45% | |
| South Fork | | | | 141 | | -29% | |
| Skagit Summer-Fall* | 56% | 16% | 2,698 | 7,551 | | | |
| Lower Skagit Fall | | | | 810 | 7% | 223% | -63% |
| Lower Sauk Summer | | | | 403 | 5% | 101% | -41% |
| Upper Skagit Summer | | | | 6,339 | -4% | 556% | -15% |
| Skagit Spring* | 28% | 24% | 415 | 1,270 | | | |
| Upper Cascade | | | | 372 | | 119% | |
| Upper Sauk | | | | 428 | -10% | 229% | 30% |
| Suiattle | | | | 471 | -13% | 177% | 18% |
| Stillaguamish Summer-F | 20% | 12% | 239 | 1,584 | | | |
| North Fork Summer | | | | 1,291 | -12% | 330% | 134% |
| South Fork Fall | | | | 293 | -4% | 47% | -2% |
| Snohomish Summer-Fal | 23% | 18% | 1,685 | 3,399 | | | |
| Skykomish Summer | | | | 1,745 | -18% | 6% | -50% |
| Snoqualmie Fall | | | | 1,654 | | 314% | |
| Green-Duwamish Fall* | 51% | 36% | 8,768 | 5,802 | -2% | 595% | 5% |
| Lake Washington Fall | | 22% | | | | | |
| Sammamish | 38% | | 73 | 214 | | 7% | -83% |
| Cedar | 38% | | 74 | 214 | | 7% | -82% |
| Puyallup Fall | 50% | 35% | 3,464 | 1,834 | | 817% | 53% |
| White River Spring | 20% | 17% | 219 | 1,011 | | 406% | 1% |
| Nisqually Fall | 66% | 53% | 9,714 | 1,109 | | 455% | 1% |
| Mid- Hood Canal Fall | 34% | 12% | 67 | 344 | | 72% | -72% |
| Skokomish Fall | 48% | 26% | 3,712 | 1,225 | | 513% | -2% |
| Dungeness Summer | 29% | 5% | 12 | 231 | | 16% | -75% |
| Elwha Summer | 30% | 5% | 71 | 1,395 | | 598% | -52% |
| ***All Chinook from Listed Populations*** | | | **31,238** | **27,435** | | | |

| **Hood Canal and Strait of Juan de Fuca Summer Chum** | | | | **Performance vs Recovery Standards** | |
|---|---|---|---|---|---|
| | Wild Exploitation Rate [4] | Southern U.S. Catch [4] | Natural Escapement | Rebuilding Exploitation Rate | Critical Escapement Threshold |
| Hood Canal | 3% | 214 | 7,437 | -8% | 83% |
| Juan de Fuca | 0.4% | 12 | 6,955 | -9% | 656% |
| ***All Summer Chum*** | | **226** | **14,392** | | |

* Populations with specific NMFS-developed standards
[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
[4] Excludes Quilcene River population.

(grey box) Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8a-1 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario A relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

| **Puget Sound Chinook** | **Alternative 2 Scenario A** | | | | **Performance vs. Recovery Standards** | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S. Wild Exploitation Rate | Southern U.S.Catch | Natural Escapement | Rebuilding Exploitation Rate[1] | Critical Escapement Threshold[2] | Viable Escapement or Escapement Goal[3] |
| Nooksack Early* | 14% | 1% | 8 | 422 | 2% | 6% | -16% |
| North Fork | | | | 186 | | -7% | |
| South Fork | | | | 236 | | 18% | |
| Skagit Summer-Fall* | 32% | 1% | 147 | 14,656 | | | |
| Lower Skagit Fall | | | | 1,571 | -17% | 526% | -28% |
| Lower Sauk Summer | | | | 782 | -19% | 291% | 15% |
| Upper Skagit Summer | | | | 12,303 | -28% | 1172% | 65% |
| Skagit Spring* | 12% | 3% | 73 | 2,073 | | | |
| Upper Cascade | | | | 607 | | 257% | |
| Upper Sauk | | | | 699 | -26% | 437% | 112% |
| Suiattle | | | | 768 | -29% | 352% | 92% |
| Stillaguamish Summer-I | 66% | 60% | 1,614 | 903 | | | |
| North Fork Summer | | | | 736 | 34% | 145% | 33% |
| South Fork Fall | | | | 167 | 42% | -16% | -44% |
| Snohomish Summer-Fal | 22% | 21% | 2,606 | 4,634 | | | |
| Skykomish Summer | | | | 2,379 | -18% | 44% | -32% |
| Snoqualmie Fall | | | | 2,255 | | 464% | |
| Green-Duwamish Fall* | 55% | 42% | 11,312 | 5,800 | 2% | 595% | 5% |
| Lake Washington Fall | | 5% | | | | | |
| Sammamish | 18% | | 18 | 307 | | 54% | -75% |
| Cedar | 18% | | 18 | 307 | | 54% | -74% |
| Puyallup Fall | 70% | 57% | 6,271 | 1,200 | | 500% | 0% |
| White River Spring | 46% | 46% | 434 | 1,000 | | 400% | 0% |
| Nisqually Fall | 72% | 63% | 14,375 | 1,100 | | 450% | 0% |
| Mid- Hood Canal Fall | 19% | 5% | 39 | 552 | | 176% | -56% |
| Skokomish Fall | 60% | 46% | 8,334 | 1,218 | | 509% | -3% |
| Dungeness Summer | 19% | 1% | 3 | 360 | | 80% | -61% |
| Elwha Summer | 19% | 1% | 16 | 2,172 | | 986% | -25% |
| ***All Chinook from Listed Populations*** | | | **45,268** | **36,704** | | | |

| **Hood Canal and Strait of Juan de Fuca Summer Chum** | | | | **Performance vs Recovery Standards** | |
|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch[4] | Natural Escapement | Rebuilding Exploitation Rate | Critical Escapement Threshold |
| Hood Canal | 0% | 0 | 7,651 | -11% | 88% |
| Juan de Fuca | 0.2% | 0 | 6,985 | -9% | 659% |
| ***All Summer Chum*** | | **0** | **14,636** | | |

* Populations with specific NMFS-developed standards
[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8a-2 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario A relative to Alternative 1 Scenario A (Proposed Action).

| **Puget Sound Chinook** | **Impacts Relative to Alternative 1 Scenario A** | | | | | |
|---|---|---|---|---|---|---|
| | Change in Wild Exploitation Rate[1] | Change in Southern U.S. Catch[1] | Change in Natural Escapement[1] | % Change in Natural Escapement[2] | Type of Impact | Magnitude of Impact |
| Nooksack Early* | -6% | -29 | 34 | 9% | | |
| North Fork | | | 15 | 9% | Beneficial | Low |
| South Fork | | | 19 | 9% | Beneficial | Low |
| Skagit Summer-Fall* | -16% | -3,747 | 3,023 | 26% | | |
| Lower Skagit Fall | | | 324 | 26% | Beneficial | Moderate |
| Lower Sauk Summer | | | 161 | 26% | Beneficial | Moderate |
| Upper Skagit Summer | | | 2,538 | 26% | Beneficial | Moderate |
| Skagit Spring* | -11% | -497 | 152 | 8% | Beneficial | Low |
| Upper Cascade | | | 45 | 8% | Beneficial | Low |
| Upper Sauk | | | 51 | 8% | Beneficial | Low |
| Suiattle | | | 56 | 8% | Beneficial | Low |
| Stillaguamish Summer-I | 49% | 1,301 | -1,419 | -61% | | |
| North Fork Summer | | | -1,156 | -61% | Negative | Substantial |
| South Fork Fall | | | -263 | -61% | Negative | Substantial |
| Snohomish Summer-Fal | 3% | 281 | -439 | -9% | | |
| Skykomish Summer | | | -225 | -9% | Negative | Low |
| Snoqualmie Fall | | | -214 | -9% | Negative | Low |
| Green-Duwamish Fall* | -7% | -4,589 | -19 | -0.3% | None | None |
| Lake Washington Fall | | | | | | |
| Sammamish | -13% | -68 | 2 | 1% | Beneficial | Low |
| Cedar | -13% | -69 | 2 | 1% | Beneficial | Low |
| Puyallup Fall | 21% | 1,247 | -1,192 | -50% | Negative | Substantial |
| White River Spring | 26% | 78 | -468 | -32% | Negative | Substantial |
| Nisqually Fall | -4% | -3,050 | -6 | -1% | Negative | Low |
| Mid- Hood Canal Fall | -7% | -56 | 21 | 4% | Beneficial | Low |
| Skokomish Fall | -3% | -1,038 | 7 | 1% | Beneficial | Low |
| Dungeness Summer | -3% | -12 | 8 | 2% | Beneficial | Low |
| Elwha Summer | -3% | -82 | 47 | 2% | Beneficial | Low |

| **Summer Chum** | **Impacts Relative to Alternative A Scenario A** | | | | | |
|---|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch[4] | Natural Escapement | % Change Escapement | Type of Impact | Magnitude of Impact |
| Hood Canal | -3% | -214 | 214 | 3% | Beneficial | Low |
| Juan de Fuca | 0% | -12 | 30 | 0% | None | None |

* Populations with specific NMFS-developed standards
[1] Alternative 1 - Alternative 2
[2] (Alternative 1 - Alternative 2) ÷ Alternative 1
[3] See explanation of impact metrics.
[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8b-1 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario B relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

| Puget Sound Chinook | Alternative 2 Scenario B | | | | Performance vs. Recovery Standards | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S. Wild Exploitation Rate | Southern U.S.Catch | Natural Escapement | Rebuilding Exploitation Rate[1] | Critical Escapement Threshold[2] | Viable Escapement or Escapement Goal[3] |
| Nooksack Early* | 19% | 1% | 9 | 412 | 7% | | -18% |
| North Fork | | | | 181 | | -9% | |
| South Fork | | | | 231 | | 15% | |
| Skagit Summer-Fall* | 41% | 1% | 147 | 13,935 | | | |
| Lower Skagit Fall | | | | 1,494 | -8% | 495% | -32% |
| Lower Sauk Summer | | | | 743 | -10% | 272% | 9% |
| Upper Skagit Summer | | | | 11,698 | -19% | 1110% | 57% |
| Skagit Spring* | 16% | 3% | 74 | 2,009 | | | |
| Upper Cascade | | | | 589 | | 246% | |
| Upper Sauk | | | | 677 | -22% | 421% | 105% |
| Suiattle | | | | 745 | -25% | 338% | 86% |
| Stillaguamish Summer-F | 67% | 59% | 1,591 | 904 | | | |
| North Fork Summer | | | | 737 | 35% | 146% | 33% |
| South Fork Fall | | | | 167 | 43% | -16% | -44% |
| Snohomish Summer-Fal | 23% | 19% | 2,347 | 4,603 | | | |
| Skykomish Summer | | | | 2,363 | -18% | 43% | -32% |
| Snoqualmie Fall | | | | 2,240 | | 460% | |
| Green-Duwamish Fall* | 56% | 38% | 10,526 | 5,800 | 3% | 595% | 5% |
| Lake Washington Fall | | 5% | | | | | |
| Sammamish | 23% | | 37 | 295 | | 48% | -76% |
| Cedar | 23% | | 18 | 295 | | 48% | -75% |
| Puyallup Fall | 71% | 53% | 5,990 | 1,200 | | 500% | 0% |
| White River Spring | 46% | 44% | 414 | 1,000 | | 400% | 0% |
| Nisqually Fall | 73% | 60% | 14,010 | 1,100 | | 450% | 0% |
| Mid- Hood Canal Fall | 25% | 5% | 39 | 527 | | 164% | -58% |
| Skokomish Fall | 61% | 40% | 7,612 | 1,231 | | 516% | -2% |
| Dungeness Summer | 24% | 1% | 3 | 344 | | 72% | -63% |
| Elwha Summer | 24% | 1% | 16 | 2,079 | | 940% | -28% |
| ***All Chinook from Listed Populations*** | | | **42,833** | **35,734** | | | |

| Hood Canal and Strait of Juan de Fuca Summer Chum | | | | Performance vs Recovery Standards | |
|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch[4] | Natural Escapement | Rebuilding Exploitation Rate | Critical Escapement Threshold |
| Hood Canal | 0% | 0 | 7,651 | -11% | 88% |
| Juan de Fuca | 0.2% | 0 | 6,985 | -9% | 659% |
| ***All Summer Chum*** | | **0** | **14,636** | | |

* Populations with specific NMFS-developed standards
[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8b-2 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario B relative to Alternative 1 Scenario B (Proposed Action).

| Puget Sound Chinook | Impacts Relative to Alternative 1 Scenario B | | | | | |
|---|---|---|---|---|---|---|
| | Change in Wild Exploitation Rate[1] | Change in Southern U.S. Catch[1] | Change in Natural Escapement[1] | % Change in Natural Escapement[2] | Type of Impact | Magnitude of Impact |
| Nooksack Early* | -6% | -29 | 47 | 13% | | |
| North Fork | | | 21 | 13% | Beneficial | Moderate |
| South Fork | | | 26 | 13% | Beneficial | Moderate |
| Skagit Summer-Fall* | -14% | -3,590 | 2,906 | 26% | | |
| Lower Skagit Fall | | | 312 | 26% | Beneficial | Moderate |
| Lower Sauk Summer | | | 155 | 26% | Beneficial | Moderate |
| Upper Skagit Summer | | | 2,439 | 26% | Beneficial | Moderate |
| Skagit Spring* | -11% | -493 | 164 | 9% | Beneficial | Low |
| Upper Cascade | | | 48 | 9% | Beneficial | Low |
| Upper Sauk | | | 55 | 9% | Beneficial | Low |
| Suiattle | | | 61 | 9% | Beneficial | Low |
| Stillaguamish Summer-F | 48% | 1,277 | -1,377 | -60% | | |
| North Fork Summer | | | -1,122 | -60% | Negative | Substantial |
| South Fork Fall | | | -255 | -60% | Negative | Substantial |
| Snohomish Summer-Fal | 1% | 61 | -298 | -6% | | |
| Skykomish Summer | | | -153 | -6% | Negative | Low |
| Snoqualmie Fall | | | -145 | -6% | Negative | Low |
| Green-Duwamish Fall* | -7% | -4,577 | -16 | -0.3% | None | None |
| Lake Washington Fall | | | | | | |
| Sammamish | -12% | -49 | 1 | 0% | None | None |
| Cedar | -12% | -67 | 1 | 0% | None | None |
| Puyallup Fall | 21% | 1,367 | -1,219 | -50% | Negative | Substantial |
| White River Spring | 26% | 91 | -459 | -31% | Negative | Substantial |
| Nisqually Fall | -3% | -2,919 | -26 | -2% | Negative | Low |
| Mid- Hood Canal Fall | -7% | -55 | 23 | 5% | Beneficial | Low |
| Skokomish Fall | -2% | -897 | -6 | 0% | None | None |
| Dungeness Summer | -3% | -12 | 8 | 2% | Beneficial | Low |
| Elwha Summer | -4% | -81 | 48 | 2% | Beneficial | Low |

| | Impacts Relative to Alternative 1 Scenario B | | | | | |
|---|---|---|---|---|---|---|
| Summer Chum | Wild Exploitation Rate[4] | Southern U.S. Catch[4] | Natural Escapement | % Change Escapement | Type of Impact | Magnitude of Impact |
| Hood Canal | -3% | -214 | 214 | 3% | Beneficial | Low |
| Juan de Fuca | 0% | -12 | 30 | 0% | None | None |

* Populations with specific NMFS-developed standards
[1] Alternative 1 - Alternative 2
[2] (Alternative 1 - Alternative 2) ÷ Alternative 1
[3] See explanation of impact metrics.
[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8c-1 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario C relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

| **Puget Sound Chinook** | **Alternative 2 Scenario C** | | | | **Performance vs. Recovery Standards** | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S. Wild Exploitation Rate | Southern U.S.Catch | Natural Escapement | Rebuilding Exploitation Rate[1] | Critical Escapement Threshold[2] | Viable Escapement or Escapement Goal[3] |
| Nooksack Early* | 14% | 1% | 6 | 304 | 2% | | -39% |
| North Fork | | | | 134 | | -33% | |
| South Fork | | | | 170 | | -15% | |
| Skagit Summer-Fall* | 33% | 1% | 105 | 10,215 | | | |
| Lower Skagit Fall | | | | 1,095 | -16% | 336% | -50% |
| Lower Sauk Summer | | | | 545 | -18% | 172% | -20% |
| Upper Skagit Summer | | | | 8,575 | -27% | 787% | 15% |
| Skagit Spring* | 12% | 3% | 53 | 1,460 | | | |
| Upper Cascade | | | | 428 | | 152% | |
| Upper Sauk | | | | 492 | -26% | 278% | 49% |
| Suiattle | | | | 541 | -29% | 218% | 35% |
| Stillaguamish Summer-F | 52% | 46% | 864 | 909 | | | |
| North Fork Summer | | | | 741 | 20% | 147% | 34% |
| South Fork Fall | | | | 168 | 28% | -16% | -44% |
| Snohomish Summer-Fal | 10% | 3% | 244 | 3,875 | | | |
| Skykomish Summer | | | | 1,989 | -18% | 21% | -43% |
| Snoqualmie Fall | | | | 1,886 | | 372% | |
| Green-Duwamish Fall* | 36% | 23% | 4,403 | 5,800 | -17% | 595% | 5% |
| Lake Washington Fall | | 5% | | | | | |
| Sammamish | 19% | | 28 | 214 | | 7% | -83% |
| Cedar | 19% | | 13 | 214 | | 7% | -82% |
| Puyallup Fall | 57% | 44% | 3,703 | 1,200 | | 500% | 0% |
| White River Spring | 23% | 23% | 156 | 1,000 | | 400% | 0% |
| Nisqually Fall | 61% | 51% | 8,324 | 1,100 | | 450% | 0% |
| Mid- Hood Canal Fall | 20% | 5% | 29 | 385 | | 93% | -69% |
| Skokomish Fall | 43% | 29% | 3,701 | 1,221 | | 511% | -2% |
| Dungeness Summer | 19% | 1% | 2 | 251 | | 26% | -73% |
| Elwha Summer | 19% | 1% | 11 | 1,516 | | 658% | -48% |
| ***All Chinook from Listed Populations*** | | | **21,642** | **29,664** | | | |

| **Hood Canal and Strait of Juan de Fuca Summer Chum** | | | | **Performance vs Recovery Standards** | |
|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch[4] | Natural Escapement | Rebuilding Exploitation Rate | Critical Escapement Threshold |
| Hood Canal | 0% | 0 | 7,651 | -11% | 88% |
| Juan de Fuca | 0.2% | 0 | 6,985 | -9% | 659% |
| ***All Summer Chum*** | | **0** | **14,636** | | |

* Populations with specific NMFS-developed standards
1 Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
2 Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
3 Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
4 Excludes Quilcene River population.

[shaded box] Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8c-2 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario C relative to Alternative 1 Scenario C (Proposed Action).

| **Puget Sound Chinook** | **Impacts Relative to Alternative 1 Scenario A** | | | | | |
|---|---|---|---|---|---|---|
| | Change in Wild Exploitation Rate[1] | Change in Southern U.S. Catch[1] | Change in Natural Escapement[1] | % Change in Natural Escapement[2] | Type of Impact | Magnitude of Impact |
| Nooksack Early* | -6% | -20 | 26 | 9% | | |
| North Fork | | | 11 | 9% | Beneficial | Low |
| South Fork | | | 15 | 9% | Beneficial | Low |
| Skagit Summer-Fall* | -16% | -2,673 | 2,182 | 27% | | |
| Lower Skagit Fall | | | 234 | 27% | Beneficial | Moderate |
| Lower Sauk Summer | | | 116 | 27% | Beneficial | Moderate |
| Upper Skagit Summer | | | 1,832 | 27% | Beneficial | Moderate |
| Skagit Spring* | -11% | -340 | 129 | 10% | Beneficial | Moderate |
| Upper Cascade | | | 38 | 10% | Beneficial | Moderate |
| Upper Sauk | | | 43 | 10% | Beneficial | Moderate |
| Suiattle | | | 48 | 10% | Beneficial | Moderate |
| Stillaguamish Summer-F | 35% | 639 | -711 | -44% | | |
| North Fork Summer | | | -579 | -44% | Negative | Substantial |
| South Fork Fall | | | -132 | -44% | Negative | Substantial |
| Snohomish Summer-Fal | -10% | -1,389 | 332 | 9% | | |
| Skykomish Summer | | | 170 | 9% | Beneficial | Low |
| Snoqualmie Fall | | | 162 | 9% | Beneficial | Low |
| Green-Duwamish Fall* | -13% | -4,782 | -1 | 0.0% | None | None |
| Lake Washington Fall | | | | | | |
| Sammamish | -14% | -45 | -9 | -4% | Negative | Low |
| Cedar | -14% | -59 | -9 | -4% | Negative | Low |
| Puyallup Fall | 7% | -69 | -598 | -33% | Negative | Substantial |
| White River Spring | 3% | -87 | -11 | -1% | Negative | Low |
| Nisqually Fall | -3% | -1,220 | -19 | -2% | Negative | Low |
| Mid- Hood Canal Fall | -6% | -36 | 18 | 5% | Beneficial | Low |
| Skokomish Fall | -2% | -465 | -18 | -1% | Negative | Low |
| Dungeness Summer | -3% | -10 | 6 | 2% | Beneficial | Low |
| Elwha Summer | -4% | -59 | 36 | 2% | Beneficial | Low |

| **Summer Chum** | **Impacts Relative to Alternative A Scenario A** | | | | | |
|---|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch[4] | Natural Escapement | % Change Escapement | Type of Impact | Magnitude of Impact |
| Hood Canal | -3% | -214 | 214 | 3% | Beneficial | Low |
| Juan de Fuca | 0% | -12 | 30 | 0% | None | None |

* Populations with specific NMFS-developed standards
1 Alternative 1 - Alternative 2
2 (Alternative 1 - Alternative 2) ÷ Alternative 1
3 See explanation of impact metrics.
4 Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8d-1 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario D relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

| **Puget Sound Chinook** | **Alternative 2 Scenario D** | | | | **Performance vs. Recovery Standards** | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S. Wild Exploitation Rate | Southern U.S.Catch | Natural Escapement | Rebuilding Exploitation Rate[1] | Critical Escapement Threshold[2] | Viable Escapement or Escapement Goal[3] |
| Nooksack Early* | 20% | 1% | 6 | 285 | 8% | | -43% |
| North Fork | | | | 125 | | -37% | |
| South Fork | | | | 160 | | -20% | |
| Skagit Summer-Fall* | 43% | 1% | 105 | 9,625 | | | |
| Lower Skagit Fall | | | | 1,032 | -6% | 311% | -53% |
| Lower Sauk Summer | | | | 513 | -8% | 157% | -25% |
| Upper Skagit Summer | | | | 8,080 | -17% | 736% | 8% |
| Skagit Spring* | 17% | 3% | 54 | 1,395 | | | |
| Upper Cascade | | | | 409 | | 140% | |
| Upper Sauk | | | | 470 | -21% | 262% | 42% |
| Suiattle | | | | 517 | -24% | 204% | 29% |
| Stillaguamish Summer-F | 52% | 43% | 817 | 919 | | | |
| North Fork Summer | | | | 749 | 20% | 150% | 36% |
| South Fork Fall | | | | 170 | 28% | -15% | -43% |
| Snohomish Summer-Fal | 13% | 3% | 248 | 3,720 | | | |
| Skykomish Summer | | | | 1,909 | -18% | 16% | -45% |
| Snoqualmie Fall | | | | 1,811 | | 353% | |
| Green-Duwamish Fall* | 38% | 18% | 3,685 | 5,800 | -15% | 595% | 5% |
| Lake Washington Fall | | 5% | | | | | |
| Sammamish | 25% | | 13 | 204 | | 2% | -84% |
| Cedar | 25% | | 13 | 204 | | 2% | -83% |
| Puyallup Fall | 59% | 39% | 3,449 | 1,200 | | 500% | 0% |
| White River Spring | 22% | 20% | 137 | 1,000 | | 400% | 0% |
| Nisqually Fall | 62% | 47% | 7,998 | 1,100 | | 450% | 0% |
| Mid- Hood Canal Fall | 28% | 5% | 29 | 361 | | 81% | -71% |
| Skokomish Fall | 46% | 23% | 3,113 | 1,215 | | 508% | -3% |
| Dungeness Summer | 26% | 1% | 2 | 237 | | 19% | -74% |
| Elwha Summer | 26% | 1% | 11 | 1,431 | | 616% | -51% |
| ***All Chinook from Listed Populations*** | | | **19,680** | **28,696** | | | |

| **Hood Canal and Strait of Juan de Fuca Summer Chum** | | | | **Performance vs Recovery Standards** | |
|---|---|---|---|---|---|
| | Wild Exploitation Rate [4] | Southern U.S. Catch [4] | Natural Escapement | Rebuilding Exploitation Rate | Critical Escapement Threshold |
| Hood Canal | 0% | 0 | 7,651 | -11% | 88% |
| Juan de Fuca | 0.2% | 0 | 6,985 | -9% | 659% |
| ***All Summer Chum*** | | **0** | **14,636** | | |

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8d-2 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario D relative to Alternative 1 Scenario D (Proposed Action).

| **Puget Sound Chinook** | **Impacts Relative to Alternative 1 Scenario A** | | | | | |
|---|---|---|---|---|---|---|
| | Change in Wild Exploitation Rate[1] | Change in Southern U.S. Catch[1] | Change in Natural Escapement[1] | % Change in Natural Escapement[2] | Type of Impact | Magnitude of Impact |
| Nooksack Early* | -6% | -21 | 33 | 13% | | |
| North Fork | | | 15 | 13% | Beneficial | Moderate |
| South Fork | | | 18 | 13% | Beneficial | Moderate |
| Skagit Summer-Fall* | -13% | -2,593 | 2,074 | 27% | | |
| Lower Skagit Fall | | | 222 | 27% | Beneficial | Moderate |
| Lower Sauk Summer | | | 111 | 27% | Beneficial | Moderate |
| Upper Skagit Summer | | | 1,741 | 27% | Beneficial | Moderate |
| Skagit Spring* | -11% | -361 | 125 | 10% | Beneficial | Moderate |
| Upper Cascade | | | 37 | 10% | Beneficial | Moderate |
| Upper Sauk | | | 42 | 10% | Beneficial | Moderate |
| Suiattle | | | 46 | 10% | Beneficial | Moderate |
| Stillaguamish Summer-F | 32% | 578 | -665 | -42% | | |
| North Fork Summer | | | -542 | -42% | Negative | Substantial |
| South Fork Fall | | | -123 | -42% | Negative | Substantial |
| Snohomish Summer-Fal | -10% | -1,437 | 321 | 9% | | |
| Skykomish Summer | | | 165 | 9% | Beneficial | Low |
| Snoqualmie Fall | | | 156 | 9% | Beneficial | Low |
| Green-Duwamish Fall* | -13% | -5,083 | -2 | 0.0% | None | None |
| Lake Washington Fall | | | | | | |
| Sammamish | -13% | -60 | -10 | -5% | Negative | Low |
| Cedar | -13% | -61 | -10 | -5% | Negative | Low |
| Puyallup Fall | 9% | -15 | -634 | -35% | Negative | Substantial |
| White River Spring | 2% | -82 | -11 | -1% | Negative | Low |
| Nisqually Fall | -4% | -1,716 | -9 | -1% | Negative | Low |
| Mid- Hood Canal Fall | -6% | -38 | 17 | 5% | Beneficial | Low |
| Skokomish Fall | -2% | -599 | -10 | -1% | Negative | Low |
| Dungeness Summer | -3% | -10 | 6 | 3% | Beneficial | Low |
| Elwha Summer | -4% | -60 | 36 | 3% | Beneficial | Low |

| **Summer Chum** | **Impacts Relative to Alternative A Scenario A** | | | | | |
|---|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch [4] | Natural Escapement | % Change Escapement | Type of Impact | Magnitude of Impact |
| Hood Canal | -3% | -214 | 214 | 3% | Beneficial | Low |
| Juan de Fuca | 0% | -12 | 30 | 0% | None | None |

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9a-1 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario A relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

| **Puget Sound Chinook** | **Alternative 3 Scenario A** | | | | **Performance vs. Recovery Standards** | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S. Wild Exploitation Rate | Southern U.S.Catch | Natural Escapement | Rebuilding Exploitation Rate[1] | Critical Escapement Threshold[2] | Viable Escapement or Escapement Goal[3] |
| Nooksack Early* | 14% | 1% | 8 | 422 | 2% | | -16% |
| North Fork | | | | 186 | | -7% | |
| South Fork | | | | 236 | | 18% | |
| Skagit Summer-Fall* | 32% | 1% | 147 | 14,656 | | | |
| Lower Skagit Fall | | | | 1,571 | -17% | 526% | -28% |
| Lower Sauk Summer | | | | 782 | -19% | 291% | 15% |
| Upper Skagit Summer | | | | 12,303 | -28% | 1172% | 65% |
| Skagit Spring* | 12% | 3% | 71 | 2,074 | | | |
| Upper Cascade | | | | 608 | | 257% | |
| Upper Sauk | | | | 699 | -26% | 438% | 112% |
| Suiattle | | | | 769 | -29% | 352% | 92% |
| Stillaguamish Summer-Fal | 8% | 2% | 47 | 2,468 | | | |
| North Fork Summer | | | | 2,011 | -24% | 570% | 264% |
| South Fork Fall | | | | 457 | -16% | 128% | 52% |
| Snohomish Summer-Fall* | 10% | 4% | 857 | 5,475 | | | |
| Skykomish Summer | | | | 2,810 | -18% | 70% | -20% |
| Snoqualmie Fall | | | | 2,665 | | 566% | |
| Green-Duwamish Fall* | 55% | 42% | 11,312 | 5,800 | 2% | 595% | 5% |
| Lake Washington Fall | | 5% | | | | | |
| Sammamish | 18% | | 18 | 307 | | 54% | -75% |
| Cedar | 18% | | 18 | 307 | | 54% | -74% |
| Puyallup Fall | 70% | 57% | 6,271 | 1,200 | | 500% | 0% |
| White River Spring | 46% | 46% | 434 | 1,000 | | 400% | 0% |
| Nisqually Fall | 72% | 63% | 14,375 | 1,100 | | 450% | 0% |
| Mid- Hood Canal Fall | 19% | 5% | 39 | 552 | | 176% | -56% |
| Skokomish Fall | 60% | 46% | 8,333 | 1,218 | | 509% | -3% |
| Dungeness Summer | 19% | 1% | 3 | 360 | | 80% | -61% |
| Elwha Summer | 19% | 1% | 16 | 2,172 | | 986% | -25% |
| ***All Chinook from Listed Populations*** | | | **41,949** | **39,111** | | | |

| **Hood Canal and Strait of Juan de Fuca Summer Chum** | | | | **Performance vs Recovery Standards** | |
|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch[4] | Natural Escapement | Rebuilding Exploitation Rate | Critical Escapement Threshold |
| Hood Canal | 0.3% | 0 | 7,651 | -11% | 88% |
| Juan de Fuca | 0.2% | 0 | 6,985 | -9% | 659% |
| ***All Summer Chum*** | | **0** | **14,636** | | |

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

(shaded) Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9a-2 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario A relative to Alternative 1 Scenario A (Proposed Action).

| **Puget Sound Chinook** | **Impacts Relative to Alternative 1 Scenario A** | | | | | |
|---|---|---|---|---|---|---|
| | Change in Wild Exploitation Rate[1] | Change in Southern U.S. Catch[1] | Change in Natural Escapement[1] | % Change in Natural Escapement[2] | Type of Impact | Magnitude of Impact |
| Nooksack Early* | -6% | -29 | 34 | 9% | | |
| North Fork | | | 15 | 9% | Beneficial | Low |
| South Fork | | | 19 | 9% | Beneficial | Low |
| Skagit Summer-Fall* | -16% | -3,747 | 3,023 | 26% | | |
| Lower Skagit Fall | | | 324 | 26% | Beneficial | Moderate |
| Lower Sauk Summer | | | 161 | 26% | Beneficial | Moderate |
| Upper Skagit Summer | | | 2,538 | 26% | Beneficial | Moderate |
| Skagit Spring* | -11% | -499 | 153 | 8% | Beneficial | Low |
| Upper Cascade | | | 45 | 8% | Beneficial | Low |
| Upper Sauk | | | 52 | 8% | Beneficial | Low |
| Suiattle | | | 57 | 8% | Beneficial | Low |
| Stillaguamish Summer-Fal | -9% | -266 | 146 | 6% | | |
| North Fork Summer | | | 119 | 6% | Beneficial | Low |
| South Fork Fall | | | 27 | 6% | Beneficial | Low |
| Snohomish Summer-Fall* | -9% | -1,468 | 402 | 8% | | |
| Skykomish Summer | | | 206 | 8% | Beneficial | Low |
| Snoqualmie Fall | | | 196 | 8% | Beneficial | Low |
| Green-Duwamish Fall* | -7% | -4,589 | -19 | -0.3% | None | None |
| Lake Washington Fall | | | | | | |
| Sammamish | -13% | -68 | 2 | 1% | Beneficial | Low |
| Cedar | -13% | -69 | 2 | 1% | Beneficial | Low |
| Puyallup Fall | 21% | 1,247 | -1,192 | -50% | Negative | Substantial |
| White River Spring | 26% | 78 | -468 | -32% | Negative | Substantial |
| Nisqually Fall | -4% | -3,050 | -6 | -1% | Negative | Low |
| Mid- Hood Canal Fall | -7% | -56 | 21 | 4% | Beneficial | Low |
| Skokomish Fall | -3% | -1,039 | 7 | 1% | Beneficial | Low |
| Dungeness Summer | -3% | -12 | 8 | 2% | Beneficial | Low |
| Elwha Summer | -3% | -82 | 47 | 2% | Beneficial | Low |

| **Summer Chum** | **Impacts Relative to Alternative A Scenario A** | | | | | |
|---|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch[4] | Natural Escapement | % Change Escapement | Type of Impact | Magnitude of Impact |
| Hood Canal | -3% | -214 | 214 | 3% | Beneficial | Low |
| Juan de Fuca | 0% | -12 | 30 | 0% | None | None |

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9b-1 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario B relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

| Puget Sound Chinook | Alternative 3 Scenario B | | | | Performance vs. Recovery Standards | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S. Wild Exploitation Rate | Southern U.S.Catch | Natural Escapement | Rebuilding Exploitation Rate[1] | Critical Escapement Threshold[2] | Viable Escapement or Escapement Goal[3] |
| Nooksack Early* | 19% | 1% | 9 | 412 | 7% | | -18% |
| North Fork | | | | 181 | | -9% | |
| South Fork | | | | 231 | | 15% | |
| Skagit Summer-Fall* | 41% | 1% | 147 | 13,935 | | | |
| Lower Skagit Fall | | | | 1,494 | -8% | 495% | -32% |
| Lower Sauk Summer | | | | 743 | -10% | 272% | 9% |
| Upper Skagit Summer | | | | 11,698 | -19% | 1110% | 57% |
| Skagit Spring* | 16% | 3% | 72 | 2,010 | | | |
| Upper Cascade | | | | 589 | | 246% | |
| Upper Sauk | | | | 677 | -22% | 421% | 105% |
| Suiattle | | | | 745 | -25% | 338% | 86% |
| Stillaguamish Summer-Fa | 10% | 2% | 48 | 2,446 | | | |
| North Fork Summer | | | | 1,993 | -22% | 564% | 261% |
| South Fork Fall | | | | 453 | -14% | 126% | 51% |
| Snohomish Summer-Fall* | 12% | 3% | 328 | 5,368 | | | |
| Skykomish Summer | | | | 2,755 | -18% | 67% | -21% |
| Snoqualmie Fall | | | | 2,613 | | 553% | |
| Green-Duwamish Fall* | 56% | 38% | 10,526 | 5,800 | 3% | 595% | 5% |
| Lake Washington Fall | | 5% | | | | | |
| Sammamish | 23% | | 37 | 295 | | 48% | -76% |
| Cedar | 23% | | 18 | 295 | | 48% | -75% |
| Puyallup Fall | 71% | 53% | 5,990 | 1,200 | | 500% | 0% |
| White River Spring | 46% | 44% | 414 | 1,000 | | 400% | 0% |
| Nisqually Fall | 73% | 60% | 14,010 | 1,100 | | 450% | 0% |
| Mid- Hood Canal Fall | 25% | 5% | 39 | 527 | | 164% | -58% |
| Skokomish Fall | 61% | 40% | 7,611 | 1,231 | | 516% | -2% |
| Dungeness Summer | 24% | 1% | 3 | 344 | | 72% | -63% |
| Elwha Summer | 24% | 1% | 16 | 2,079 | | 940% | -28% |
| ***All Chinook from Listed Populations*** | | | **39,268** | **38,042** | | | |

| Hood Canal and Strait of Juan de Fuca Summer Chum | | | | Performance vs Recovery Standards | |
|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch[4] | Natural Escapement | Rebuilding Exploitation Rate | Critical Escapement Threshold |
| Hood Canal | 0.3% | 0 | 7,651 | -11% | 88% |
| Juan de Fuca | 0.2% | 0 | 6,985 | -9% | 659% |
| ***All Summer Chum*** | | **0** | **14,636** | | |

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9b-2 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario B relative to Alternative 1 Scenario B (Proposed Action).

| Puget Sound Chinook | Impacts Relative to Alternative 1 Scenario B | | | | | |
|---|---|---|---|---|---|---|
| | Change in Wild Exploitation Rate[1] | Change in Southern U.S. Catch[1] | Change in Natural Escapement[1] | % Change in Natural Escapement[2] | Type of Impact | Magnitude of Impact |
| Nooksack Early* | -6% | -29 | 47 | 13% | | |
| North Fork | | | 21 | 13% | Beneficial | Moderate |
| South Fork | | | 26 | 13% | Beneficial | Moderate |
| Skagit Summer-Fall* | -14% | -3,590 | 2,906 | 26% | | |
| Lower Skagit Fall | | | 312 | 26% | Beneficial | Moderate |
| Lower Sauk Summer | | | 155 | 26% | Beneficial | Moderate |
| Upper Skagit Summer | | | 2,439 | 26% | Beneficial | Moderate |
| Skagit Spring* | -11% | -495 | 165 | 9% | Beneficial | Low |
| Upper Cascade | | | 48 | 9% | Beneficial | Low |
| Upper Sauk | | | 56 | 9% | Beneficial | Low |
| Suiattle | | | 61 | 9% | Beneficial | Low |
| Stillaguamish Summer-Fa | -9% | -266 | 165 | 7% | | |
| North Fork Summer | | | 134 | 7% | Beneficial | Low |
| South Fork Fall | | | 31 | 7% | Beneficial | Low |
| Snohomish Summer-Fall* | -10% | -1,958 | 467 | 10% | | |
| Skykomish Summer | | | 240 | 10% | Beneficial | Moderate |
| Snoqualmie Fall | | | 227 | 10% | Beneficial | Moderate |
| Green-Duwamish Fall* | -7% | -4,577 | -16 | -0.3% | None | None |
| Lake Washington Fall | | | | | | |
| Sammamish | -12% | -49 | 1 | 0% | None | None |
| Cedar | -12% | -67 | 1 | 0% | None | None |
| Puyallup Fall | 21% | 1,367 | -1,219 | -50% | Negative | Substantial |
| White River Spring | 26% | 91 | -459 | -31% | Negative | Substantial |
| Nisqually Fall | -3% | -2,919 | -26 | -2% | Negative | Low |
| Mid- Hood Canal Fall | -7% | -55 | 23 | 5% | Beneficial | Low |
| Skokomish Fall | -2% | -898 | -6 | 0% | None | None |
| Dungeness Summer | -3% | -12 | 8 | 2% | Beneficial | Low |
| Elwha Summer | -4% | -81 | 48 | 2% | Beneficial | Low |

| Summer Chum | Impacts Relative to Alternative A Scenario B | | | | | |
|---|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch[4] | Natural Escapement | % Change Escapement | Type of Impact | Magnitude of Impact |
| Hood Canal | -3% | -214 | 214 | 3% | Beneficial | Low |
| Juan de Fuca | 0% | -12 | 30 | 0% | None | None |

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9c-1 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario C relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

| **Puget Sound Chinook** | **Alternative C Scenario C** | | | | **Performance vs. Recovery Standards** | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S. Wild Exploitation Rate | Southern U.S.Catch | Natural Escapement | Rebuilding Exploitation Rate[1] | Critical Escapement Threshold[2] | Viable Escapement or Escapement Goal[3] |
| Nooksack Early* | 14% | 1% | 6 | 304 | 2% | | -39% |
| North Fork | | | | 134 | | -33% | |
| South Fork | | | | 170 | | -15% | |
| Skagit Summer-Fall* | 33% | 1% | 105 | 10,215 | | | |
| Lower Skagit Fall | | | | 1,095 | -16% | 336% | -50% |
| Lower Sauk Summer | | | | 545 | -18% | 172% | -20% |
| Upper Skagit Summer | | | | 8,575 | -27% | 787% | 15% |
| Skagit Spring* | 12% | 3% | 53 | 1,460 | | | |
| Upper Cascade | | | | 428 | | 152% | |
| Upper Sauk | | | | 492 | -26% | 278% | 49% |
| Suiattle | | | | 541 | -29% | 218% | 35% |
| Stillaguamish Summer-Fal | 8% | 2% | 35 | 1,738 | | | |
| North Fork Summer | | | | 1,416 | -24% | 372% | 157% |
| South Fork Fall | | | | 322 | -16% | 61% | 7% |
| Snohomish Summer-Fall* | 10% | 3% | 244 | 3,875 | | | |
| Skykomish Summer | | | | 1,989 | -18% | 21% | -43% |
| Snoqualmie Fall | | | | 1,886 | | 372% | |
| Green-Duwamish Fall* | 36% | 23% | 4,403 | 5,800 | -17% | 595% | 5% |
| Lake Washington Fall | | 5% | | | | | |
| Sammamish | 19% | | 28 | 214 | | 7% | -83% |
| Cedar | 19% | | 13 | 214 | | 7% | -82% |
| Puyallup Fall | 57% | 44% | 3,703 | 1,200 | | 500% | 0% |
| White River Spring | 23% | 23% | 156 | 1,000 | | 400% | 0% |
| Nisqually Fall | 61% | 51% | 8,324 | 1,100 | | 450% | 0% |
| Mid- Hood Canal Fall | 20% | 5% | 29 | 385 | | 93% | -69% |
| Skokomish Fall | 43% | 29% | 3,701 | 1,221 | | 511% | -2% |
| Dungeness Summer | 19% | 1% | 2 | 251 | | 26% | -73% |
| Elwha Summer | 19% | 1% | 11 | 1,516 | | 658% | -48% |
| ***All Chinook from Listed Populations*** | | | **20,813** | **30,493** | | | |

| **Hood Canal and Strait of Juan de Fuca Summer Chum** | | | | **Performance vs Recovery Standards** | |
|---|---|---|---|---|---|
| | Wild Exploitation Rate [4] | Southern U.S. Catch [4] | Natural Escapement | Rebuilding Exploitation Rate | Critical Escapement Threshold |
| Hood Canal | 0% | 0 | 7,651 | -11% | 88% |
| Juan de Fuca | 0.2% | 0 | 6,985 | -9% | 659% |
| ***All Summer Chum*** | | **0** | **14,636** | | |

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9c-2 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario C relative to Alternative 1 Scenario C (Proposed Action).

| **Puget Sound Chinook** | **Impacts Relative to Alternative 1 Scenario A** | | | | | |
|---|---|---|---|---|---|---|
| | Change in Wild Exploitation Rate[1] | Change in Southern U.S. Catch[1] | Change in Natural Escapement[1] | % Change in Natural Escapement[2] | Type of Impact | Magnitude of Impact |
| Nooksack Early* | -6% | -20 | 26 | 9% | | |
| North Fork | | | 11 | 9% | Beneficial | Low |
| South Fork | | | 15 | 9% | Beneficial | Low |
| Skagit Summer-Fall* | -16% | -2,673 | 2,182 | 27% | | |
| Lower Skagit Fall | | | 234 | 27% | Beneficial | Moderate |
| Lower Sauk Summer | | | 116 | 27% | Beneficial | Moderate |
| Upper Skagit Summer | | | 1,832 | 27% | Beneficial | Moderate |
| Skagit Spring* | -11% | -340 | 129 | 10% | Beneficial | Moderate |
| Upper Cascade | | | 38 | 10% | Beneficial | Moderate |
| Upper Sauk | | | 43 | 10% | Beneficial | Moderate |
| Suiattle | | | 48 | 10% | Beneficial | Moderate |
| Stillaguamish Summer-Fal | -9% | -190 | 118 | 7% | | |
| North Fork Summer | | | 96 | 7% | Beneficial | Low |
| South Fork Fall | | | 22 | 7% | Beneficial | Low |
| Snohomish Summer-Fall* | -10% | -1,389 | 332 | 9% | | |
| Skykomish Summer | | | 170 | 9% | Beneficial | Low |
| Snoqualmie Fall | | | 162 | 9% | Beneficial | Low |
| Green-Duwamish Fall* | -13% | -4,782 | -1 | 0.0% | None | None |
| Lake Washington Fall | | | | | | |
| Sammamish | -14% | -45 | -9 | -4% | Negative | Low |
| Cedar | -14% | -59 | -9 | -4% | Negative | Low |
| Puyallup Fall | 7% | -69 | -598 | -33% | Negative | Substantial |
| White River Spring | 3% | -87 | -11 | -1% | Negative | Low |
| Nisqually Fall | -3% | -1,220 | -19 | -2% | Negative | Low |
| Mid- Hood Canal Fall | -6% | -36 | 18 | 5% | Beneficial | Low |
| Skokomish Fall | -2% | -465 | -18 | -1% | Negative | Low |
| Dungeness Summer | -3% | -10 | 6 | 2% | Beneficial | Low |
| Elwha Summer | -4% | -59 | 36 | 2% | Beneficial | Low |

| **Summer Chum** | **Impacts Relative to Alternative A Scenario A** | | | | | |
|---|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch [4] | Natural Escapement | % Change Escapement | Type of Impact | Magnitude of Impact |
| Hood Canal | -3% | -214 | 214 | 3% | Beneficial | Low |
| Juan de Fuca | 0% | -12 | 30 | 0% | None | None |

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9d-1 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario D relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

| **Puget Sound Chinook** | **Alternative 3 Scenario D** | | | | **Performance vs. Recovery Standards** | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S. Wild Exploitation Rate | Southern U.S.Catch | Natural Escapement | Rebuilding Exploitation Rate[1] | Critical Escapement Threshold[2] | Viable Escapement or Escapement Goal[3] |
| Nooksack Early* | 20% | 1% | 6 | 285 | 8% | | -43% |
| North Fork | | | | 125 | | -37% | |
| South Fork | | | | 160 | | -20% | |
| Skagit Summer-Fall* | 43% | 1% | 105 | 9,625 | | | |
| Lower Skagit Fall | | | | 1,032 | -6% | 311% | -53% |
| Lower Sauk Summer | | | | 513 | -8% | 157% | -25% |
| Upper Skagit Summer | | | | 8,080 | -17% | 736% | 8% |
| Skagit Spring* | 17% | 3% | 54 | 1,395 | | | |
| Upper Cascade | | | | 409 | | 140% | |
| Upper Sauk | | | | 470 | -21% | 262% | 42% |
| Suiattle | | | | 517 | -24% | 204% | 29% |
| Stillaguamish Summer-Fal | 11% | 2% | 35 | 1,702 | | | |
| North Fork Summer | | | | 1,387 | -21% | 362% | 151% |
| South Fork Fall | | | | 315 | -13% | 57% | 5% |
| Snohomish Summer-Fall* | 13% | 3% | 248 | 3,720 | | | |
| Skykomish Summer | | | | 1,909 | -18% | 16% | -45% |
| Snoqualmie Fall | | | | 1,811 | | 353% | |
| Green-Duwamish Fall* | 38% | 18% | 3,685 | 5,800 | -15% | 595% | 5% |
| Lake Washington Fall | | 5% | | | | | |
| Sammamish | 25% | | 28 | 204 | | 2% | -84% |
| Cedar | 25% | | 13 | 204 | | 2% | -83% |
| Puyallup Fall | 59% | 39% | 3,449 | 1,200 | | 500% | 0% |
| White River Spring | 22% | 20% | 137 | 1,000 | | 400% | 0% |
| Nisqually Fall | 62% | 47% | 7,998 | 1,100 | | 450% | 0% |
| Mid- Hood Canal Fall | 28% | 5% | 29 | 361 | | 81% | -71% |
| Skokomish Fall | 46% | 23% | 3,113 | 1,215 | | 508% | -3% |
| Dungeness Summer | 26% | 1% | 2 | 237 | | 19% | -74% |
| Elwha Summer | 26% | 1% | 11 | 1,431 | | 616% | -51% |
| ***All Chinook from Listed Populations*** | | | **18,913** | **29,479** | | | |

| **Hood Canal and Strait of Juan de Fuca Summer Chum** | | | | **Performance vs Recovery Standards** | |
|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch[4] | Natural Escapement | Rebuilding Exploitation Rate | Critical Escapement Threshold |
| Hood Canal | 0.3% | 0 | 7,651 | -11% | 88% |
| Juan de Fuca | 0.2% | 0 | 6,985 | -9% | 659% |
| ***All Summer Chum*** | | **0** | **14,636** | | |

* Populations with specific NMFS-developed standards

1 Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

2 Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

3 Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

4 Excludes Quilcene River population.

(shaded) Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9d-2 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario D relative to Alternative 1 Scenario D (Proposed Action).

| **Puget Sound Chinook** | **Impacts Relative to Alternative 1 Scenario A** | | | | | |
|---|---|---|---|---|---|---|
| | Change in Wild Exploitation Rate[1] | Change in Southern U.S. Catch[1] | Change in Natural Escapement[1] | % Change in Natural Escapement[2] | Type of Impact | Magnitude of Impact |
| Nooksack Early* | -6% | -21 | 33 | 13% | | |
| North Fork | | | 15 | 13% | Beneficial | Moderate |
| South Fork | | | 18 | 13% | Beneficial | Moderate |
| Skagit Summer-Fall* | -13% | -2,593 | 2,074 | 27% | | |
| Lower Skagit Fall | | | 222 | 27% | Beneficial | Moderate |
| Lower Sauk Summer | | | 111 | 27% | Beneficial | Moderate |
| Upper Skagit Summer | | | 1,741 | 27% | Beneficial | Moderate |
| Skagit Spring* | -11% | -361 | 125 | 10% | Beneficial | Moderate |
| Upper Cascade | | | 37 | 10% | Beneficial | Moderate |
| Upper Sauk | | | 42 | 10% | Beneficial | Moderate |
| Suiattle | | | 46 | 10% | Beneficial | Moderate |
| Stillaguamish Summer-Fal | -9% | -204 | 118 | 7% | | |
| North Fork Summer | | | 96 | 7% | Beneficial | Low |
| South Fork Fall | | | 22 | 7% | Beneficial | Low |
| Snohomish Summer-Fall* | -10% | -1,437 | 321 | 9% | | |
| Skykomish Summer | | | 165 | 9% | Beneficial | Low |
| Snoqualmie Fall | | | 156 | 9% | Beneficial | Low |
| Green-Duwamish Fall* | -13% | -5,083 | -2 | 0.0% | None | None |
| Lake Washington Fall | | | | | | |
| Sammamish | -13% | -45 | -10 | -5% | Negative | Low |
| Cedar | -13% | -61 | -10 | -5% | Negative | Low |
| Puyallup Fall | 9% | -15 | -634 | -35% | Negative | Substantial |
| White River Spring | 2% | -82 | -11 | -1% | Negative | Low |
| Nisqually Fall | -4% | -1,716 | -9 | -1% | Negative | Low |
| Mid- Hood Canal Fall | -6% | -38 | 17 | 5% | Beneficial | Low |
| Skokomish Fall | -2% | -599 | -10 | -1% | Negative | Low |
| Dungeness Summer | -3% | -10 | 6 | 3% | Beneficial | Low |
| Elwha Summer | -4% | -60 | 36 | 3% | Beneficial | Low |

| **Summer Chum** | **Impacts Relative to Alternative A Scenario A** | | | | | |
|---|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S.Catch | Natural Escapement | % Change Escapement | Type of Impact | Magnitude of Impact |
| Hood Canal | -3% | -214 | 214 | 3% | Beneficial | Low |
| Juan de Fuca | 0% | -12 | 30 | 0% | None | None |

* Populations with specific NMFS-developed standards

1 Alternative 1 - Alternative 2

2 (Alternative 1 - Alternative 2) ÷ Alternative 1

3 See explanation of impact metrics.

4 Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10a-1 Performance of Alternative 4 (No Fishing) under Scenario A relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

| Puget Sound Chinook | Alternative 4 Scenario A | | | | Performance vs. Recovery Standards | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S. Wild Exploitation Rate | Southern U.S.Catch | Natural Escapement | Rebuilding Exploitation Rate[1] | Critical Escapement Threshold[2] | Viable Escapement or Escapement Goal[3] |
| Nooksack Early* | 14% | 1% | 8 | 422 | 2% | | -16% |
| North Fork | | | | 186 | | -7% | |
| South Fork | | | | 236 | | 18% | |
| Skagit Summer-Fall* | 32% | 1% | 147 | 14,656 | | | |
| Lower Skagit Fall | | | | 1,571 | -17% | 526% | -28% |
| Lower Sauk Summer | | | | 782 | -19% | 291% | 15% |
| Upper Skagit Summer | | | | 12,303 | -28% | 1172% | 65% |
| Skagit Spring* | 12% | 3% | 71 | 2,074 | | | |
| Upper Cascade | | | | 608 | | 257% | |
| Upper Sauk | | | | 699 | -26% | 438% | 112% |
| Suiattle | | | | 769 | -29% | 352% | 92% |
| Stillaguamish Summer-Fal | 8% | 2% | 47 | 2,468 | | | |
| North Fork Summer | | | | 2,011 | -24% | 570% | 264% |
| South Fork Fall | | | | 457 | -16% | 128% | 52% |
| Snohomish Summer-Fall* | 9% | 3% | 329 | 5,504 | | | |
| Skykomish Summer | | | | 2,825 | -18% | 71% | -19% |
| Snoqualmie Fall | | | | 2,679 | | 570% | |
| Green-Duwamish Fall* | 18% | 5% | 1,675 | 10,558 | -35% | 1164% | 91% |
| Lake Washington Fall | | 5% | | | | | |
| Sammamish | 18% | | 37 | 307 | | 54% | -75% |
| Cedar | 18% | | 18 | 307 | | 54% | -74% |
| Puyallup Fall | 18% | 5% | 629 | 3,286 | | 1543% | 174% |
| White River Spring | 2% | 1% | 18 | 1,831 | | 816% | 83% |
| Nisqually Fall | 16% | 7% | 2,142 | 3,338 | | 1569% | 203% |
| Mid- Hood Canal Fall | 19% | 5% | 39 | 552 | | 176% | -56% |
| Skokomish Fall | 19% | 5% | 1,054 | 2,482 | | 1141% | 99% |
| Dungeness Summer | 19% | 1% | 3 | 360 | | 80% | -61% |
| Elwha Summer | 19% | 1% | 16 | 2,172 | | 986% | -25% |
| ***All Chinook from Listed Populations*** | | | **6,233** | **50,317** | | | |

| Hood Canal and Strait of Juan de Fuca Summer Chum | | | | Performance vs Recovery Standards | |
|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch | Natural Escapement | Rebuilding Exploitation Rate | Critical Escapement Threshold |
| Hood Canal | 0.3% | 0 | 7,651 | -11% | 88% |
| Juan de Fuca | 0.2% | 0 | 6,985 | -9% | 659% |
| ***All Summer Chum*** | | **0** | **14,636** | | |

* Populations with specific NMFS-developed standards
[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10a-2 Performance of Alternative 4 (No Fishing) under Scenario A relative to Alternative 1 Scenario A (Proposed Action).

| Puget Sound Chinook | Impacts Relative to Alternative 1 Scenario A | | | | | |
|---|---|---|---|---|---|---|
| | Change in Wild Exploitation Rate[1] | Change in Southern U.S. Catch[1] | Change in Natural Escapement[1] | % Change in Natural Escapement[2] | Type of Impact | Magnitude of Impact |
| Nooksack Early* | -6% | -29 | 34 | 9% | | |
| North Fork | | | 15 | 9% | Beneficial | Low |
| South Fork | | | 19 | 9% | Beneficial | Low |
| Skagit Summer-Fall* | -16% | -3,747 | 3,023 | 26% | | |
| Lower Skagit Fall | | | 324 | 26% | Beneficial | Moderate |
| Lower Sauk Summer | | | 161 | 26% | Beneficial | Moderate |
| Upper Skagit Summer | | | 2,538 | 26% | Beneficial | Moderate |
| Skagit Spring* | -11% | -499 | 153 | 8% | Beneficial | Low |
| Upper Cascade | | | 45 | 8% | Beneficial | Low |
| Upper Sauk | | | 52 | 8% | Beneficial | Low |
| Suiattle | | | 57 | 8% | Beneficial | Low |
| Stillaguamish Summer-Fal | -9% | -266 | 146 | 6% | | |
| North Fork Summer | | | 119 | 6% | Beneficial | Low |
| South Fork Fall | | | 27 | 6% | Beneficial | Low |
| Snohomish Summer-Fall* | -10% | -1,996 | 431 | 8% | | |
| Skykomish Summer | | | 221 | 8% | Beneficial | Low |
| Snoqualmie Fall | | | 210 | 8% | Beneficial | Low |
| Green-Duwamish Fall* | -44% | -14,226 | 4,739 | 81.4% | Beneficial | Substantial |
| Lake Washington Fall | | | | | | |
| Sammamish | -13% | -49 | 2 | 1% | Beneficial | Low |
| Cedar | -13% | -69 | 2 | 1% | Beneficial | Low |
| Puyallup Fall | -31% | -4,395 | 894 | 37% | Beneficial | Substantial |
| White River Spring | -18% | -338 | 363 | 25% | Beneficial | Moderate |
| Nisqually Fall | -60% | -15,283 | 2,232 | 202% | Beneficial | Substantial |
| Mid- Hood Canal Fall | -7% | -56 | 21 | 4% | Beneficial | Low |
| Skokomish Fall | -44% | -8,318 | 1,271 | 105% | Beneficial | Substantial |
| Dungeness Summer | -3% | -12 | 8 | 2% | Beneficial | Low |
| Elwha Summer | -3% | -82 | 47 | 2% | Beneficial | Low |

| | Impacts Relative to Alternative A Scenario A | | | | | |
|---|---|---|---|---|---|---|
| Summer Chum | Wild Exploitation Rate[4] | Southern U.S.Catch | Natural Escapement | % Change Escapement | Type of Impact | Magnitude of Impact |
| Hood Canal | -3% | -214 | 214 | 3% | Beneficial | Low |
| Juan de Fuca | 0% | -12 | 30 | 0% | None | None |

* Populations with specific NMFS-developed standards
[1] Alternative 1 - Alternative 2
[2] (Alternative 1 - Alternative 2) ÷ Alternative 1
[3] See explanation of impact metrics.
[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10b-1 Performance of Alternative 4 (No Fishing) under Scenario B relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

| **Puget Sound Chinook** | **Alternative 4 Scenario B** | | | | **Performance vs. Recovery Standards** | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S. Wild Exploitation Rate | Southern U.S.Catch | Natural Escapement | Rebuilding Exploitation Rate[1] | Critical Escapement Threshold[2] | Viable Escapement or Escapement Goal[3] |
| Nooksack Early* | 19% | 1% | 9 | 412 | 7% | | -18% |
| North Fork | | | | 181 | | -9% | |
| South Fork | | | | 231 | | 15% | |
| Skagit Summer-Fall* | 41% | 1% | 147 | 13,935 | | | |
| Lower Skagit Fall | | | | 1,494 | -8% | 495% | -32% |
| Lower Sauk Summer | | | | 743 | -10% | 272% | 9% |
| Upper Skagit Summer | | | | 11,698 | -19% | 1110% | 57% |
| Skagit Spring* | 16% | 3% | 72 | 2,010 | | | |
| Upper Cascade | | | | 589 | | 246% | |
| Upper Sauk | | | | 677 | -22% | 421% | 105% |
| Suiattle | | | | 745 | -25% | 338% | 86% |
| Stillaguamish Summer-Fal | 10% | 2% | 48 | 2,446 | | | |
| North Fork Summer | | | | 1,993 | -22% | 564% | 261% |
| South Fork Fall | | | | 453 | -14% | 126% | 51% |
| Snohomish Summer-Fall* | 12% | 3% | 328 | 5,368 | | | |
| Skykomish Summer | | | | 2,755 | -18% | 67% | -21% |
| Snoqualmie Fall | | | | 2,613 | | 553% | |
| Green-Duwamish Fall* | 23% | 5% | 1,684 | 10,153 | -30% | 1116% | 84% |
| Lake Washington Fall | | 5% | | | | | |
| Sammamish | 23% | | 37 | 295 | | 48% | -76% |
| Cedar | 23% | | 18 | 295 | | 48% | -75% |
| Puyallup Fall | 23% | 5% | 633 | 3,160 | | 1480% | 163% |
| White River Spring | 3% | 1% | 18 | 1,792 | | 796% | 79% |
| Nisqually Fall | 21% | 7% | 2,183 | 3,261 | | 1531% | 196% |
| Mid- Hood Canal Fall | 25% | 5% | 39 | 527 | | 164% | -58% |
| Skokomish Fall | 25% | 5% | 1,054 | 2,370 | | 1085% | 90% |
| Dungeness Summer | 24% | 1% | 3 | 344 | | 72% | -63% |
| Elwha Summer | 24% | 1% | 16 | 2,079 | | 940% | -28% |
| ***All Chinook from Listed Populations*** | | | **6,289** | **48,447** | | | |

| **Hood Canal and Strait of Juan de Fuca Summer Chum** | | | | **Performance vs Recovery Standards** | |
|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch | Natural Escapement | Rebuilding Exploitation Rate | Critical Escapement Threshold |
| Hood Canal | 0.3% | 0 | 7,651 | -11% | 88% |
| Juan de Fuca | 0.2% | 0 | 6,985 | -9% | 659% |
| ***All Summer Chum*** | | **0** | **14,636** | | |

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

(shaded) Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10b-2 Performance of Alternative 4 (No Fishing) under Scenario B relative to Alternative 1 Scenario B (Proposed Action).

| **Puget Sound Chinook** | **Impacts Relative to Alternative 1 Scenario B** | | | | | |
|---|---|---|---|---|---|---|
| | Change in Wild Exploitation Rate[1] | Change in Southern U.S. Catch[1] | Change in Natural Escapement[1] | % Change in Natural Escapement[2] | Type of Impact | Magnitude of Impact |
| Nooksack Early* | -6% | -29 | 47 | 13% | | |
| North Fork | | | 21 | 13% | Beneficial | Moderate |
| South Fork | | | 26 | 13% | Beneficial | Moderate |
| Skagit Summer-Fall* | -14% | -3,590 | 2,906 | 26% | | |
| Lower Skagit Fall | | | 312 | 26% | Beneficial | Moderate |
| Lower Sauk Summer | | | 155 | 26% | Beneficial | Moderate |
| Upper Skagit Summer | | | 2,439 | 26% | Beneficial | Moderate |
| Skagit Spring* | -11% | -495 | 165 | 9% | Beneficial | Low |
| Upper Cascade | | | 48 | 9% | Beneficial | Low |
| Upper Sauk | | | 56 | 9% | Beneficial | Low |
| Suiattle | | | 61 | 9% | Beneficial | Low |
| Stillaguamish Summer-Fal | -9% | -266 | 165 | 7% | | |
| North Fork Summer | | | 134 | 7% | Beneficial | Low |
| South Fork Fall | | | 31 | 7% | Beneficial | Low |
| Snohomish Summer-Fall* | -10% | -1,958 | 467 | 10% | | |
| Skykomish Summer | | | 240 | 10% | Beneficial | Moderate |
| Snoqualmie Fall | | | 227 | 10% | Beneficial | Moderate |
| Green-Duwamish Fall* | -40% | -13,419 | 4,337 | 74.6% | Beneficial | Substantial |
| Lake Washington Fall | | | | | | |
| Sammamish | -12% | -49 | 1 | 0% | None | None |
| Cedar | -12% | -67 | 1 | 0% | None | None |
| Puyallup Fall | -27% | -3,990 | 741 | 31% | Beneficial | Substantial |
| White River Spring | -17% | -305 | 333 | 23% | Beneficial | Moderate |
| Nisqually Fall | -55% | -14,746 | 2,135 | 190% | Beneficial | Substantial |
| Mid- Hood Canal Fall | -7% | -55 | 23 | 5% | Beneficial | Low |
| Skokomish Fall | -38% | -7,455 | 1,133 | 92% | Beneficial | Substantial |
| Dungeness Summer | -3% | -12 | 8 | 2% | Beneficial | Low |
| Elwha Summer | -4% | -81 | 48 | 2% | Beneficial | Low |

| **Summer Chum** | **Impacts Relative to Alternative 1 Scenario B** | | | | | |
|---|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S.Catch | Natural Escapement | % Change Escapement | Type of Impact | Magnitude of Impact |
| Hood Canal | -3% | -214 | 214 | 3% | Beneficial | Low |
| Juan de Fuca | 0% | -12 | 30 | 0% | None | None |

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10c-1 Performance of Alternative 4 (No Fishing) under Scenario Crelative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

| Puget Sound Chinook | Alternative 4 Scenario C | | | | Performance vs. Recovery Standards | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S. Wild Exploitation Rate | Southern U.S.Catch | Natural Escapement | Rebuilding Exploitation Rate[1] | Critical Escapement Threshold[2] | Viable Escapement or Escapement Goal[3] |
| Nooksack Early* | 14% | 1% | 6 | 304 | 2% | | -39% |
| North Fork | | | | 134 | | -33% | |
| South Fork | | | | 170 | | -15% | |
| Skagit Summer-Fall* | 33% | 1% | 105 | 10,215 | | | |
| Lower Skagit Fall | | | | 1,095 | -16% | 336% | -50% |
| Lower Sauk Summer | | | | 545 | -18% | 172% | -20% |
| Upper Skagit Summer | | | | 8,575 | -27% | 787% | 15% |
| Skagit Spring* | 12% | 3% | 53 | 1,460 | | | |
| Upper Cascade | | | | 428 | | 152% | |
| Upper Sauk | | | | 492 | -26% | 278% | 49% |
| Suiattle | | | | 541 | -29% | 218% | 35% |
| Stillaguamish Summer-Fal | 8% | 2% | 35 | 1,738 | | | |
| North Fork Summer | | | | 1,416 | -24% | 372% | 157% |
| South Fork Fall | | | | 322 | -16% | 61% | 7% |
| Snohomish Summer-Fall* | 10% | 3% | 244 | 3,875 | | | |
| Skykomish Summer | | | | 1,989 | -18% | 21% | -43% |
| Snoqualmie Fall | | | | 1,886 | | 372% | |
| Green-Duwamish Fall* | 19% | 5% | 1,228 | 7,367 | -34% | 782% | 33% |
| Lake Washington Fall | | 5% | | | | | |
| Sammamish | 19% | | 27 | 214 | | 7% | -83% |
| Cedar | 19% | | 13 | 214 | | 7% | -82% |
| Puyallup Fall | 19% | 5% | 461 | 2,293 | | 1047% | 91% |
| White River Spring | 2% | 1% | 14 | 1,283 | | 542% | 28% |
| Nisqually Fall | 17% | 8% | 1,600 | 2,330 | | 1065% | 112% |
| Mid- Hood Canal Fall | 20% | 5% | 29 | 385 | | 93% | -69% |
| Skokomish Fall | 20% | 5% | 769 | 1,730 | | 765% | 38% |
| Dungeness Summer | 19% | 1% | 2 | 251 | | 26% | -73% |
| Elwha Summer | 19% | 1% | 11 | 1,516 | | 658% | -48% |
| ***All Chinook from Listed Populations*** | | | **4,597** | **35,175** | | | |

| Hood Canal and Strait of Juan de Fuca Summer Chum | | | | Performance vs Recovery Standards | |
|---|---|---|---|---|---|
| | Wild Exploitation Rate [4] | Southern U.S. Catch | Natural Escapement | Rebuilding Exploitation Rate | Critical Escapement Threshold |
| Hood Canal | 0.3% | 0 | 7,651 | -11% | 88% |
| Juan de Fuca | 0.2% | 0 | 6,985 | -9% | 659% |
| ***All Summer Chum*** | | **0** | **14,636** | | |

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10c-2 Performance of Alternative 4 (No Fishing) under Scenario C relative to Alternative 1 Scenario C (Proposed Action).

| Puget Sound Chinook | Impacts Relative to Alternative 1 Scenario C | | | | | |
|---|---|---|---|---|---|---|
| | Change in Wild Exploitation Rate[1] | Change in Southern U.S. Catch[1] | Change in Natural Escapement[1] | % Change in Natural Escapement[2] | Type of Impact | Magnitude of Impact |
| Nooksack Early* | -6% | -20 | 26 | 9% | | |
| North Fork | | | 11 | 9% | Beneficial | Low |
| South Fork | | | 15 | 9% | Beneficial | Low |
| Skagit Summer-Fall* | -16% | -2,673 | 2,182 | 27% | | |
| Lower Skagit Fall | | | 234 | 27% | Beneficial | Moderate |
| Lower Sauk Summer | | | 116 | 27% | Beneficial | Moderate |
| Upper Skagit Summer | | | 1,832 | 27% | Beneficial | Moderate |
| Skagit Spring* | -11% | -340 | 129 | 10% | Beneficial | Moderate |
| Upper Cascade | | | 38 | 10% | Beneficial | Moderate |
| Upper Sauk | | | 43 | 10% | Beneficial | Moderate |
| Suiattle | | | 48 | 10% | Beneficial | Moderate |
| Stillaguamish Summer-Fal | -9% | -190 | 118 | 7% | | |
| North Fork Summer | | | 96 | 7% | Beneficial | Low |
| South Fork Fall | | | 22 | 7% | Beneficial | Low |
| Snohomish Summer-Fall* | -10% | -1,389 | 332 | 9% | | |
| Skykomish Summer | | | 170 | 9% | Beneficial | Low |
| Snoqualmie Fall | | | 162 | 9% | Beneficial | Low |
| Green-Duwamish Fall* | -30% | -7,957 | 1,566 | 27.0% | Beneficial | Moderate |
| Lake Washington Fall | | | | | | |
| Sammamish | -14% | -45 | -9 | -4% | Negative | Low |
| Cedar | -14% | -59 | -9 | -4% | Negative | Low |
| Puyallup Fall | -31% | -3,311 | 495 | 28% | Beneficial | Moderate |
| White River Spring | -18% | -229 | 272 | 27% | Beneficial | Moderate |
| Nisqually Fall | -47% | -7,944 | 1,211 | 108% | Beneficial | Substantial |
| Mid- Hood Canal Fall | -6% | -36 | 18 | 5% | Beneficial | Low |
| Skokomish Fall | -25% | -3,397 | 491 | 40% | Beneficial | Substantial |
| Dungeness Summer | -3% | -10 | 6 | 2% | Beneficial | Low |
| Elwha Summer | -4% | -59 | 36 | 2% | Beneficial | Low |

| | Impacts Relative to Alternative 1 Scenario C | | | | | |
|---|---|---|---|---|---|---|
| **Summer Chum** | Wild Exploitation Rate[4] | Southern U.S.Catch | Natural Escapement | % Change Escapement | Type of Impact | Magnitude of Impact |
| Hood Canal | -3% | -214 | 214 | 3% | Beneficial | Low |
| Juan de Fuca | 0% | -12 | 30 | 0% | None | None |

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10d-1 Performance of Alternative 4 (No Fishing) under Scenario D relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

| **Puget Sound Chinook** | **Alternative 4 Scenario D** | | | | **Performance vs. Recovery Standards** | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S. Wild Exploitation Rate | Southern U.S.Catch | Natural Escapement | Rebuilding Exploitation Rate[1] | Critical Escapement Threshold[2] | Viable Escapement or Escapement Goal[3] |
| Nooksack Early* | 20% | 1% | 6 | 285 | 8% | | -43% |
| North Fork | | | | 125 | | -37% | |
| South Fork | | | | 160 | | -20% | |
| Skagit Summer-Fall* | 43% | 1% | 105 | 9,625 | | | |
| Lower Skagit Fall | | | | 1,032 | -6% | 311% | -53% |
| Lower Sauk Summer | | | | 513 | -8% | 157% | -25% |
| Upper Skagit Summer | | | | 8,080 | -17% | 736% | 8% |
| Skagit Spring* | 17% | 3% | 54 | 1,395 | | | |
| Upper Cascade | | | | 409 | | 140% | |
| Upper Sauk | | | | 470 | -21% | 262% | 42% |
| Suiattle | | | | 517 | -24% | 204% | 29% |
| Stillaguamish Summer-Fa | 11% | 2% | 35 | 1,702 | | | |
| North Fork Summer | | | | 1,387 | -21% | 362% | 151% |
| South Fork Fall | | | | 315 | -13% | 57% | 5% |
| Snohomish Summer-Fall* | 13% | 3% | 244 | 3,720 | | | |
| Skykomish Summer | | | | 1,909 | -18% | 16% | -45% |
| Snoqualmie Fall | | | | 1,811 | | 353% | |
| Green-Duwamish Fall* | 25% | 5% | 1,232 | 7,006 | -28% | 739% | 27% |
| Lake Washington Fall | | 5% | | | | | |
| Sammamish | 25% | | 13 | 204 | | 2% | -84% |
| Cedar | 25% | | 13 | 204 | | 2% | -83% |
| Puyallup Fall | 25% | 5% | 463 | 2,180 | | 990% | 82% |
| White River Spring | 3% | 1% | 14 | 1,246 | | 523% | 25% |
| Nisqually Fall | 23% | 8% | 1,630 | 2,264 | | 1032% | 106% |
| Mid- Hood Canal Fall | 28% | 5% | 29 | 361 | | 81% | -71% |
| Skokomish Fall | 28% | 5% | 767 | 1,622 | | 711% | 30% |
| Dungeness Summer | 26% | 1% | 2 | 237 | | 19% | -74% |
| Elwha Summer | 26% | 1% | 11 | 1,431 | | 616% | -51% |
| ***All Chinook from Listed Populations*** | | | **4,619** | **33,482** | | | |

| **Hood Canal and Strait of Juan de Fuca Summer Chum** | | | | **Performance vs Recovery Standards** | |
|---|---|---|---|---|---|
| | Wild Exploitation Rate[4] | Southern U.S. Catch | Natural Escapement | Rebuilding Exploitation Rate | Critical Escapement Threshold |
| Hood Canal | 0.3% | 0 | 7,651 | -11% | 88% |
| Juan de Fuca | 0.2% | 0 | 6,985 | -9% | 659% |
| ***All Summer Chum*** | | **0** | **14,636** | | |

* Populations with specific NMFS-developed standards
[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
[4] Excludes Quilcene River population.

(shaded) Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10d-2 Performance of Alternative 4 (No Fishing) under Scenario D relative to Alternative 1 Scenario D (Proposed Action).

| **Puget Sound Chinook** | **Impacts Relative to Alternative 1 Scenario D** | | | | | |
|---|---|---|---|---|---|---|
| | Change in Wild Exploitation Rate[1] | Change in Southern U.S. Catch[1] | Change in Natural Escapement[1] | % Change in Natural Escapement[2] | Type of Impact | Magnitude of Impact |
| Nooksack Early* | -6% | -21 | 33 | 13% | | |
| North Fork | | | 15 | 13% | Beneficial | Moderate |
| South Fork | | | 18 | 13% | Beneficial | Moderate |
| Skagit Summer-Fall* | -13% | -2,593 | 2,074 | 27% | | |
| Lower Skagit Fall | | | 222 | 27% | Beneficial | Moderate |
| Lower Sauk Summer | | | 111 | 27% | Beneficial | Moderate |
| Upper Skagit Summer | | | 1,741 | 27% | Beneficial | Moderate |
| Skagit Spring* | -11% | -361 | 125 | 10% | Beneficial | Moderate |
| Upper Cascade | | | 37 | 10% | Beneficial | Moderate |
| Upper Sauk | | | 42 | 10% | Beneficial | Moderate |
| Suiattle | | | 46 | 10% | Beneficial | Moderate |
| Stillaguamish Summer-Fa | -9% | -204 | 118 | 7% | | |
| North Fork Summer | | | 96 | 7% | Beneficial | Low |
| South Fork Fall | | | 22 | 7% | Beneficial | Low |
| Snohomish Summer-Fall* | -10% | -1,441 | 321 | 9% | | |
| Skykomish Summer | | | 165 | 9% | Beneficial | Low |
| Snoqualmie Fall | | | 156 | 9% | Beneficial | Low |
| Green-Duwamish Fall* | -26% | -7,536 | 1,204 | 20.8% | Beneficial | Moderate |
| Lake Washington Fall | | | | | | |
| Sammamish | -13% | -60 | -10 | -5% | Negative | Low |
| Cedar | -13% | -61 | -10 | -5% | Negative | Low |
| Puyallup Fall | -25% | -3,001 | 346 | 19% | Beneficial | Moderate |
| White River Spring | -17% | -205 | 235 | 23% | Beneficial | Moderate |
| Nisqually Fall | -43% | -8,084 | 1,155 | 104% | Beneficial | Substantial |
| Mid- Hood Canal Fall | -6% | -38 | 17 | 5% | Beneficial | Low |
| Skokomish Fall | -20% | -2,945 | 397 | 32% | Beneficial | Substantial |
| Dungeness Summer | -3% | -10 | 6 | 3% | Beneficial | Low |
| Elwha Summer | -4% | -60 | 36 | 3% | Beneficial | Low |

| | **Impacts Relative to Alternative 1 Scenario D** | | | | | |
|---|---|---|---|---|---|---|
| **Summer Chum** | Wild Exploitation Rate[4] | Southern U.S.Catch | Natural Escapement | % Change Escapement | Type of Impact | Magnitude of Impact |
| Hood Canal | -3% | -214 | 214 | 3% | Beneficial | Low |
| Juan de Fuca | 0% | -12 | 30 | 0% | None | None |

* Populations with specific NMFS-developed standards
[1] Alternative 1 - Alternative 2
[2] (Alternative 1 - Alternative 2) ÷ Alternative 1
[3] See explanation of impact metrics.
[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

### 4.3.2 Unlisted Salmonid Species

Puget Sound populations of coho, sockeye, pink, chum salmon, and steelhead would also be affected by the Proposed Action or alternatives considered in this Environmental Impact Statement. As noted in Section 3.3, Fish: Affected Environment, chinook and coho salmon from Washington and Oregon coastal populations are infrequently taken in Puget Sound fisheries, and therefore would not be measurably affected. The co-managers aggregate populations of sockeye, coho, pink, chum salmon, and steelhead into seven management units: the Nooksack-Samish, Skagit, Stillaguamish, and Snohomish River management units in North Puget Sound; the South Sound management unit, which includes streams south of the Snohomish; the Hood Canal management unit; and the Strait of Juan de Fuca management unit. The two sockeye salmon management units – the Skagit (Baker) River and South Puget Sound (Cedar River) – are managed to achieve escapement goals. Coho salmon harvest is managed to not exceed exploitation rate ceilings specific to each management unit. These exploitation rate ceilings would be set annually according to the forecast abundance of each management unit, and appropriate to the productivity level implied by the forecast. Pink and chum salmon fisheries are managed to achieve escapement goals for each management unit. Since these coho, chum, sockeye, pink salmon, and steelhead populations are unlisted populations, NMFS has not set Endangered Species Act standards for them. The standards of performance referred to in this Environmental Impact Statement are the exploitation rate ceilings, or escapement goals established by the co-managers beginning with the 2001 management year.

The alternatives considered all assume that river fisheries could remain open from December through March when adult chinook salmon are absent from Puget Sound streams. More than 95 percent of the net harvest of steelhead occurs during this period. The model employed in the analysis is able to account for the relatively small changes in tribal harvest that would occur in late summer and fall fisheries when chinook salmon and summer steelhead presence overlaps. Under Alternative 2 or 3, catch in these fisheries would be reduced relative to Alternative 1. Because such a large part of steelhead harvest occurs between December and March, the effect on catch and escapement of steelhead under Alternative 2 or 3 relative to Alternative 1 would be a low to moderately beneficial impact.

It is important to note that, in the modeling for this impact analysis, the abundance of species other than chinook salmon within the action area was held constant with the base period; that is, the "scenarios" used to simulate variability in abundance and fishing regimes outside the action area were not applied for these species.

#### 4.3.2.1 Alternative 1 – Proposed Action/Status Quo

Impacts to Unlisted Puget Sound Salmon Populations

Under Alternative 1, the modeled total Southern U.S. catch of unlisted salmon species originating from Puget Sound is predicted to be 476,794 coho salmon, 92,850 sockeye salmon, 419,957 pink salmon, and 715,235 fall and winter chum salmon.

Under Alternative 1, escapement of naturally-spawning coho salmon is predicted to be 326,114 fish. As shown in Table 4.3-11, it is predicted that the co-managers' exploitation rate goals would be met under Alternative 1 for all Puget Sound coho salmon management units by margins ranging from 13 to 27 percent. An exploitation rate ceiling has not been established for South Puget Sound coho salmon, but the exploitation rate achieved under Alternative 1 would balance natural spawning capacity and hatchery program objectives.

Under Alternative 1, the escapement of Baker River sockeye salmon is predicted to exceed the goal by almost 300 percent. A recreational and tribal fishery for Cedar River sockeye salmon was modeled under Alternative 1 with a predicted total catch of 92,600 sockeye. Under this Alternative, escapement is predicted to be 17 percent below the goal for the Cedar River (Table 4.3-11).

The escapement of naturally-spawning pink salmon to streams in the seven management units is predicted to be 897,976 fish. Under Alternative 1, escapements of pink salmon are predicted to exceed the goal by a substantial margin for the Nooksack, Skagit, and Snohomish River pink salmon management units, and are predicted to be substantially below the goals for South Puget Sound and Hood Canal. A pink salmon escapement goal is not available for the Strait of Juan de Fuca management unit.

Table 4.3-11 Performance of Alternative 1 (Proposed Action) relative to exploitation rate objectives or escapement goals for coho, sockeye, pink, and fall-winter chum salmon.

| | | | | | | Performance vs Standards | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Exploit. Rate Objective | Southern U.S. Catch | Natural Escapement | Escapement Goal | Exploitation Rate | Escapement |
| **Coho** | | | | | | | |
| Nooksack/Samish | 50% | 75% | 41,215 | 8,182 | | -25% | |
| Skagit | 37% | 60% | 42,493 | 73,624 | | -23% | |
| Stillaguamish | 37% | 50% | 12,069 | 24,017 | | -13% | |
| Snohomish | 33% | 60% | 76,720 | 136,873 | | -27% | |
| South Sound | 55% | | 246,383 | 47,086 | | | |
| Hood Canal | 42% | 65% | 42,909 | 19,012 | | -23% | |
| Juan de Fuca | 14% | 40% | 15,005 | 17,320 | | -26% | |
| ***All Coho*** | | | **476,794** | **326,114** | | | |
| **Sockeye** | | | | | | | |
| Skagit | | | 250 | 11,823 | 3,000 | | 294% |
| South Sound | | | 92,600 | 291,916 | 350,000 | | -17% |
| ***All Sockeye*** | | | **92,850** | **303,739** | | | |
| **Pink** | | | | | | | |
| Nooksack/Samish | 7% | | 7,184 | 91,988 | 50,000 | | 84% |
| Skagit | 30% | | 184,614 | 430,792 | 330,000 | | 31% |
| Stillaguamish | 36% | | 90,690 | 164,000 | 155,000 | | 6% |
| Snohomish | 37% | | 101,193 | 173,000 | 120,000 | | 44% |
| South Sound | 9% | | 1,319 | 13,283 | 25,000 | | -47% |
| Hood Canal | 39% | | 33,467 | 20,065 | 125,000 | | -84% |
| Juan de Fuca | 35% | | 1,490 | 4,848 | | | |
| ***All Pink*** | | | **419,957** | **897,976** | | | |
| **Fall Chum** | | | | | | | |
| Nooksack/Samish | 56% | | 54,738 | 35,610 | 20,800 | | 71% |
| Skagit | 9% | | 4,253 | 42,237 | 40,000 | | 6% |
| Stillaguamish | 59% | | 21,577 | 14,400 | 13,100 | | 10% |
| Snohomish | 51% | | 54,284 | 17,600 | 10,200 | | 73% |
| South Sound | 68% | | 361,258 | 150,923 | 64,350 | | 135% |
| Hood Canal | 49% | | 218,987 | 50,382 | 39,900 | | 26% |
| Juan de Fuca | 7% | | 137 | 2,585 | 3,600 | | -28% |
| ***All Fall Chum*** | | | **715,234** | **313,737** | | | |

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Escapement of naturally-spawning fall and winter chum salmon to streams in the seven management units under Alternative 1 is predicted to be 313,737 fish. Under Alternative 1, escapement is predicted to meet the co-managers' escapement goals by substantial margins for the Nooksack, Snohomish, South Puget Sound, and Hood Canal chum salmon management units, and by low margins for the Skagit and Stillaguamish management units. Escapement of naturally-spawning fall and winter chum salmon is predicted to be substantially less than the goal for the Strait of Juan de Fuca Management Unit (see Table 4.3-11).

#### 4.3.2.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

<u>Impacts to Unlisted Puget Sound Salmon Populations and Comparison to Alternative 1</u>

Under Alternative 2, the modeled total Southern U.S. catch of unlisted salmon species originating from Puget Sound is predicted to be 197,691 coho salmon, zero sockeye salmon, 115,732 pink salmon, and 152,384 fall and winter chum salmon.

As shown in Table 4.3-12a, the co-managers' exploitation rate goals are predicted to be met under Alternative 2 for all Puget Sound coho salmon management units by margins ranging from 26 to 62 percent. Exploitation rates on naturally-spawning coho salmon are predicted to be substantially lower than with Alternative 1, by margins ranging from 24 to 56 percent, while coho escapement is predicted to increase substantially, by margins ranging from 9 to 74 percent (see Table 4.3-12b).

With Alternative 2, Cedar River sockeye salmon fisheries would be closed, with the result that escapement is predicted to increase by approximately 92,600 fish, bringing escapement to slightly over the goal of 300,000. Catch of Baker River sockeye is predicted to be zero. The predicted increase in Cedar River sockeye salmon escapement of approximately 24 percent would constitute a moderate beneficial impact. The increased escapement of Baker River sockeye salmon would constitute a small (low) beneficial impact relative to Alternative 1. Harvest of Puget Sound pink salmon is predicted to decline by more than 339,000 compared to Alternative 1. Spawning escapement to the Nooksack and South Puget Sound management units is predicted to increase by a small margin and by a substantial margin (ranging from 22 to 58 percent) to the Skagit, Stillaguamish, Snohomish, Hood Canal, and Strait of Juan de Fuca units (Table 4.3-12b). As with Alternative 1, escapements are not predicted to meet the escapement goals for the South Sound and Hood Canal management units.

Table 4.3-12a Performance of Alternative 2 relative to exploitation rate objectives or escapement goals for coho, sockeye, pink, and fall-winter chum salmon.

| | | | | | | Performance vs Standards: | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Exploit. Rate Objective | Southern U.S. Catch | Natural Escapement | Escapement Goal | Exploitation Rate | Escapement |
| **Coho** | | | | | | | |
| Nooksack/Samish | 13% | 75% | 7,386 | 14,272 | | -62% | |
| Skagit | 6% | 60% | 5,019 | 109,887 | | -54% | |
| Stillaguamish | 24% | 50% | 8,024 | 28,689 | | -26% | |
| Snohomish | 19% | 60% | 47,594 | 165,820 | | -41% | |
| South Sound | 33% | | 115,245 | 69,945 | | | |
| Hood Canal | 12% | 65% | 7,931 | 28,533 | | -53% | |
| Juan de Fuca | 6% | 40% | 6,492 | 18,819 | | -34% | |
| ***All Coho*** | | | **197,691** | **435,965** | | | |
| **Sockeye** | | | | | | | |
| Skagit | 0% | | 0 | 12,073 | 3,000 | | 302% |
| South Sound | 0% | | 0 | 362,292 | 350,000 | | 4% |
| ***All Sockeye*** | | | **0** | **237,256** | | | |
| **Pink** | | | | | | | |
| Nooksack/Samish | 0% | | 0 | 99,172 | 50,000 | | 98% |
| Skagit | 0% | | 0 | 615,406 | 330,000 | | 86% |
| Stillaguamish | 21% | | 54,331 | 200,360 | 155,000 | | 29% |
| Snohomish | 0% | | 34,800 | 274,192 | 120,000 | | 128% |
| South Sound | 4% | | 600 | 13,999 | 25,000 | | -44% |
| Hood Canal | 16% | | 26,001 | 27,556 | 125,000 | | -78% |
| Juan de Fuca | 15% | | 0 | 6,338 | | | |
| ***All Pink*** | | | **115,732** | **1,237,023** | | | |
| **Fall Chum** | | | | | | | |
| Nooksack/Samish | 1% | | 1,090 | 79,482 | 20,800 | | 282% |
| Skagit | 1% | | 252 | 46,071 | 40,000 | | 15% |
| Stillaguamish | 2% | | 852 | 34,194 | 13,100 | | 161% |
| Snohomish | 0% | | 239 | 35,583 | 10,200 | | 249% |
| South Sound | 16% | | 83,501 | 399,761 | 64,350 | | 521% |
| Hood Canal | 4% | | 66,448 | 95,473 | 39,900 | | 139% |
| Juan de Fuca | 2% | | 2 | 2,722 | 3,600 | | -24% |
| ***All Fall Chum*** | | | **152,384** | **693,286** | | | |

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-12b Performance of Alternative 2 (Escapement goal management at the management unit level) relative to Alternative 1 for coho, sockeye, pink, and chum salmon.

| | Changes Relative to Alternative 1 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S.Catch | Total Mortality | Natural Escapement | % Change Escapement | Type of Impact | Magnitude of Impact |
| **Coho** | | | | | | | |
| Nooksack/Samish | -37% | (33829) | (6,151) | 6,090 | 74% | beneficial | substantial |
| Skagit | -31% | (37474) | (36,580) | 36,263 | 49% | beneficial | substantial |
| Stillaguamish | -13% | (4045) | (4,782) | 4,672 | 19% | beneficial | substantial |
| Snohomish | -14% | (29126) | (29,567) | 28,947 | 21% | beneficial | substantial |
| South Sound | -22% | (131138) | (23,503) | 22,859 | 49% | beneficial | substantial |
| Hood Canal | -30% | (34978) | (9,662) | 9,521 | 50% | beneficial | substantial |
| Juan de Fuca | -8% | (8513) | (1,529) | 1,499 | 9% | beneficial | low |
| ***All Coho*** | | **(279103)** | **(111774)** | **109851** | 34% | | |
| **Sockeye** | | | | | | | |
| Skagit | | (250) | | 250 | | | |
| South Sound | | (92600) | | 70,376 | | | |
| ***All Sockeye*** | | **(92850)** | | **250** | | | |
| **Pink** | | | | | | | |
| Nooksack/Samish | | (7184) | (7,184) | 7,184 | 8% | beneficial | low |
| Skagit | | (184614) | (184,611) | 184,614 | 43% | beneficial | substantial |
| Stillaguamish | | (36359) | (36,359) | 36,360 | 22% | beneficial | substantial |
| Snohomish | | (66393) | (101,192) | 101,192 | 58% | beneficial | substantial |
| South Sound | | (719) | (716) | 716 | 5% | beneficial | low |
| Hood Canal | | (7466) | (7,491) | 7,491 | 37% | beneficial | substantial |
| Juan de Fuca | | (1490) | (1,490) | 1,490 | 31% | beneficial | substantial |
| ***All Pink*** | | **(304225)** | **(339043)** | **339047** | 38% | | |
| **Fall Chum** | | | | | | | |
| Nooksack/Samish | | (53648) | (43,872) | 43,872 | 123% | beneficial | substantial |
| Skagit | | (4001) | (3,834) | 3,834 | 9% | beneficial | low |
| Stillaguamish | | (20725) | (19,789) | 19,794 | 137% | beneficial | substantial |
| Snohomish | | (54045) | (17,983) | 17,983 | 102% | beneficial | substantial |
| South Sound | | (277757) | (248,838) | 248,838 | 165% | beneficial | substantial |
| Hood Canal | | (152539) | (45,091) | 45,091 | 89% | beneficial | substantial |
| Juan de Fuca | | (135) | (137) | 137 | 5% | beneficial | low |
| ***All Fall Chum*** | | **(562,850)** | **(379,544)** | **379,549** | 121% | | |

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003

Escapement of most naturally-spawning fall and winter chum salmon management units is predicted to increase by more than 100 percent compared to Alternative 1. As with Alternative 1, chum salmon escapement is predicted to meet the co-managers' escapement goals by substantial margins in all but the Skagit and Strait of Juan de Fuca chum salmon management units. The increase in escapement for the Skagit management unit is predicted to be low compared to Alternative 1, and the Strait of Juan de Fuca management unit is not predicted to meet its escapement goal.

Based on the expected increases in escapement of naturally-spawning fish that are predicted to occur under Alternative 2 relative to Alternative 1, the impacts of Alternative 2 to populations in the two sockeye salmon management units would be beneficial, but low. Impacts to all other populations of coho, fall and winter chum, and pink salmon are predicted to be moderately to substantially beneficial. However, as explained previously, for populations where escapements exceed current goals by substantial margins, the potential for density-dependent decreases in productivity due to competition for mates, food, or territory would be heightened; therefore, natural production by these populations is unlikely to increase in direct proportion to the predicted increase in spawning escapement.

#### 4.3.2.3 Alternative 3 – Escapement Goal Management at the Population Level With Terminal Fisheries Only

Impacts to Unlisted Puget Sound Salmon Populations

Under Alternative 3, the modeled total Southern U.S. catch of unlisted salmon species originating from Puget Sound is predicted to be 157,753 coho salmon, zero sockeye salmon, 26,601 pink salmon, and 151,578 fall and winter chum salmon.

As shown in Table 4.3-13a, the co-managers' exploitation rate goals are predicted to be met under Alternative 2 for all Puget Sound coho salmon management units by margins ranging from 34 to 62 percent. Exploitation rates on naturally-spawning coho salmon are predicted to be substantially lower than with Alternative 1, by margins ranging from 8 to 37 percent, while coho escapement is predicted to increase substantially, by margins ranging from 9 to 74 percent (see Table 4.3-13a).

Table 4.3-13a Performance of Alternative 3 relative to exploitation rate objectives or escapement goals for coho, sockeye, pink, and fall-winter chum salmon.

| | | | | | | Performance vs Standards | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Exploit. Rate Objective | Southern U.S. Catch | Natural Escapement | Escapement Goal | Exploitation Rate | Escapement |
| **Coho** | | | | | | | |
| Nooksack/Samish | 13% | 75% | 7,386 | 14,272 | | -62% | |
| Skagit | 6% | 60% | 5,019 | 109,887 | | -54% | |
| Stillaguamish | 8% | 50% | 1,908 | 34,840 | | -42% | |
| Snohomish | 8% | 60% | 13,772 | 187,066 | | -52% | |
| South Sound | 33% | | 115,245 | 69,945 | | | |
| Hood Canal | 12% | 65% | 7,931 | 28,533 | | -53% | |
| Juan de Fuca | 6% | 40% | 6,492 | 18,819 | | -34% | |
| ***All Coho*** | | | **157,753** | **463,362** | | | |
| **Sockeye** | | | | | | | |
| Skagit | 0% | | 0 | 12,073 | 3,000 | | 302% |
| South Sound | 0% | | 0 | 224,422 | 350,000 | | -36% |
| ***All Sockeye*** | | | | **236,495** | | | |
| **Pink** | | | | | | | |
| Nooksack/Samish | 0% | | 0 | 99,172 | 50,000 | | 98% |
| Skagit | 0% | | 0 | 615,406 | 330,000 | | 86% |
| Stillaguamish | 0% | | 0 | 254,690 | 155,000 | | 64% |
| Snohomish | 0% | | 0 | 274,193 | 120,000 | | 128% |
| South Sound | 4% | | 600 | 13,999 | 25,000 | | -44% |
| Hood Canal | 16% | | 26,001 | 27,556 | 125,000 | | -78% |
| Juan de Fuca | 15% | | 0 | 6,338 | | | |
| ***All Pink*** | | | **26,601** | **1,291,354** | | | |
| **Fall Chum** | | | | | | | |
| Nooksack/Samish | 1% | | 1,090 | 79,482 | 20,800 | | 282% |
| Skagit | 1% | | 252 | 46,071 | 40,000 | | 15% |
| Stillaguamish | 0% | | 46 | 34,964 | 13,100 | | 167% |
| Snohomish | 0% | | 239 | 35,583 | 10,200 | | 249% |
| South Sound | 16% | | 83,501 | 399,761 | 64,350 | | 521% |
| Hood Canal | 4% | | 66,448 | 95,473 | 39,900 | | 139% |
| Juan de Fuca | 2% | | 2 | 2,722 | 3,600 | | -24% |
| ***All Fall Chum*** | | | **151,578** | **694,056** | | | |

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

With Alternative 3, Cedar River sockeye salmon fisheries would be closed and escapement is predicted to increase by approximately 92,600 fish, bringing escapement to slightly over the goal of 300,000 (Table 4.3-13a). Catch of Baker River sockeye is predicted to be zero. The predicted increase in Cedar River sockeye escapement by approximately 24 percent would constitute a moderate beneficial impact. The increased escapement of Baker River sockeye would constitute a small (low) beneficial impact relative to Alternative 1 (Table 4.3-13b). Modeled harvest of Puget Sound pink salmon are predicted to decline by more than 393,000 compared to Alternative 1. Spawning escapement is predicted to increase by a small margin in the Skagit and South Puget Sound management units, and by a substantial margin (ranging from 89 to 143 percent) in other management units. As with Alternative 1, pink salmon escapements are not predicted to meet the escapement goals for the South Sound and Hood Canal management units.

Escapement of most naturally-spawning fall and winter chum salmon management units is predicted to increase by more than 100 percent compared to Alternative 1 (Table 4.3-13a). As with Alternative 1, chum salmon escapement is predicted to meet the co-managers' escapement goals by substantial margins in all but the Skagit and Strait of Juan de Fuca management units. The increase in escapement for the Skagit management unit is predicted to be low compared to Alternative 1, and the Strait of Juan de Fuca management unit is not predicted to meet its escapement goal (Table 4.3-13b).

Based on the predicted increases in escapement of naturally-spawning fish that would occur under Alternative 3 relative to Alternative 1, the impacts of Alternative 3 on populations in the two sockeye salmon management units would be beneficial, but low. Impacts to all other populations of coho salmon, fall-winter chum salmon, and pink salmon would be moderately to substantially beneficial. However, as explained previously, for populations where escapements exceed current goals by substantial margins, the potential for density-dependent declines in productivity based on competition for mates, food or territory would be heightened, with the result that natural production by these populations is unlikely to increase proportionate to the predicted increase in spawning escapement.

Table 4.3-13b Performance of Alternative 3 (Escapement goal management at the population level) relative to Alternative 1 for coho, sockeye, pink, and chum salmon.

| | Changes Relative to Alternative 1 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S.Catch | Total Mortality | Natural Escapement | % Change Escapement | Type of Impact | Magnitude of Impact |
| **Coho** | | | | | | | |
| Nooksack/Samish | -37% | (33829) | (6,151) | 6,090 | 74% | beneficial | substantial |
| Skagit | -31% | (37474) | (36,580) | 36,263 | 49% | beneficial | substantial |
| Stillaguamish | -29% | (10161) | (10,969) | 10,823 | 45% | beneficial | substantial |
| Snohomish | -25% | (62948) | (51,002) | 50,193 | 37% | beneficial | substantial |
| South Sound | -22% | (131138) | (23,503) | 22,859 | 49% | beneficial | substantial |
| Hood Canal | -30% | (34978) | (9,662) | 9,521 | 50% | beneficial | substantial |
| Juan de Fuca | -8% | (8513) | (1,529) | 1,499 | 9% | beneficial | low |
| ***All Coho*** | | **(319041)** | **(139396)** | **137248** | 42% | | |
| **Sockeye** | | | | | | | |
| Skagit | | (250) | | 250 | | | |
| South Sound | | (92600) | | (67,494) | | | |
| ***All Sockeye*** | | **(92850)** | | **250** | | | |
| **Pink** | | | | | | | |
| Nooksack/Samish | | (7184) | (7,184) | 7,184 | 8% | beneficial | low |
| Skagit | | (184614) | (184,611) | 184,614 | 43% | beneficial | substantial |
| Stillaguamish | | (90690) | (90,690) | 90,690 | 55% | beneficial | substantial |
| Snohomish | | (101193) | (101,192) | 101,193 | 58% | beneficial | substantial |
| South Sound | | (719) | (716) | 716 | 5% | beneficial | low |
| Hood Canal | | (7466) | (7,491) | 7,491 | 37% | beneficial | substantial |
| Juan de Fuca | | (1490) | (1,490) | 1,490 | 31% | beneficial | substantial |
| ***All Pink*** | | **(393356)** | **(393374)** | **393378** | 44% | | |
| **Fall Chum** | | | | | | | |
| Nooksack/Samish | | (53648) | (43,872) | 43,872 | 123% | beneficial | substantial |
| Skagit | | (4001) | (3,834) | 3,834 | 9% | beneficial | low |
| Stillaguamish | | (21531) | (20,564) | 20,564 | 143% | beneficial | substantial |
| Snohomish | | (54045) | (17,983) | 17,983 | 102% | beneficial | substantial |
| South Sound | | (277757) | (248,838) | 248,838 | 165% | beneficial | substantial |
| Hood Canal | | (152539) | (45,091) | 45,091 | 89% | beneficial | substantial |
| Juan de Fuca | | (135) | (137) | 137 | 5% | beneficial | low |
| ***All Fall Chum*** | | **(563,656)** | **(380,319)** | **380,319** | 121% | | |

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003

#### 4.3.2.4 Alternative 4 – No Action/No Authorized Take

Impacts to Unlisted Puget Sound Salmon Populations

Under Alternative 4, the modeled Southern U.S. catch of unlisted salmon species originating from Puget Sound is 70,260 coho salmon, zero sockeye salmon, 6,459 pink salmon, and 38,877 fall and winter chum salmon. The predicted catch would be the same under all scenarios.

Under Alternative 4, the No Authorized Take alternative, catch of unlisted salmonids would be limited to terminal areas when naturally-spawning chinook salmon are absent. The effect of Alternative 4 is predicted to be a further reduction in catch and exploitation rates, with further increases in escapement of both natural- and hatchery-origin salmonids compared to Alternative 2 or 3. The exploitation rates on coho salmon populations are predicted to decline to 6 to 8 percent. These rates are predicted to be lower than with Alternative 1 by substantial margins (25 to 49%) (Table 4.3-14b). Spawning escapement is predicted to increase substantially (by 168,000 for all management units) relative to Alternative 1. Exploitation rate goals are predicted to be met for all management units, by margins ranging from 34 to 68 percent (see Table 4.3-14a). With Alternative 4, Cedar River sockeye salmon fisheries would be closed and escapement is predicted to increase by approximately 92,600 fish, bringing escapement to slightly more than the goal of 300,000. Baker River sockeye salmon catch is predicted to be zero. The predicted increase in Cedar River sockeye escapement by approximately 24 percent would constitute a moderate beneficial impact. The increased escapement of Baker River sockeye would constitute a small (low) beneficial impact relative to Alternative 1.

Under Alternative 4, exploitation rates in Puget Sound fisheries for pink salmon are predicted to be zero for the Nooksack, Skagit, Stillaguamish, Snohomish, and South Puget Sound management units. Spawning escapement is predicted to increase by a low amount for the Nooksack and South Sound management units, and substantially for the Skagit, Stillaguamish, Snohomish, Hood Canal, and Strait of Juan de Fuca management units, compared to the outcome of Alternative 1 (Table 4.3-14b). As with Alternative 2 or 3, it is predicted that escapement goals for pink salmon would be substantially exceeded. Also as with Alternative 2 or 3, although escapements would increase for the South Puget Sound and Hood Canal pink salmon management units, the escapement goals still would not be met.

Table 4.3-14a Performance of Alternative 4 relative to exploitation rate objectives or escapement goals for coho, sockeye, pink, and fall-winter chum salmon.

| | | | | | | Performance vs Standards | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Exploit. Rate Objective | Southern U.S. Catch | Natural Escapement | Escapement Goal | Exploitation Rate | Escapement |
| **Coho** | | | | | | | |
| Nooksack/Samish | 7% | 75% | 2,463 | 15,305 | | -68% | |
| Skagit | 6% | 60% | 6,409 | 110,022 | | -54% | |
| Stillaguamish | 8% | 50% | 5,205 | 34,840 | | -42% | |
| Snohomish | 8% | 60% | 1,910 | 187,066 | | -52% | |
| South Sound | 6% | | 13,784 | 97,804 | | | |
| Hood Canal | 7% | 65% | 33,886 | 30,345 | | -58% | |
| Juan de Fuca | 6% | 40% | 6,603 | 18,819 | | -34% | |
| ***All Coho*** | | | **70,260** | **494,201** | | | |
| **Sockeye** | | | | | | | |
| Skagit | 0% | | 0 | 12,073 | 3,000 | | 302% |
| South Sound | 0% | | 0 | 224,422 | 350,000 | | -36% |
| ***All Sockeye*** | | | | **236,495** | | | |
| **Pink** | | | | | | | |
| Nooksack/Samish | 0% | | 0 | 99,172 | 50,000 | | 98% |
| Skagit | 0% | | 0 | 615,406 | 330,000 | | 86% |
| Stillaguamish | 0% | | 0 | 254,690 | 155,000 | | 64% |
| Snohomish | 0% | | 0 | 274,193 | 120,000 | | 128% |
| South Sound | | | | 14,596 | 25,000 | | -42% |
| Hood Canal | 10% | | 6,459 | 47,387 | 125,000 | | -62% |
| Juan de Fuca | 15% | | 0 | 6,338 | | | |
| ***All Pink*** | | | **6,459** | **1,311,782** | | | |
| **Fall Chum** | | | | | | | |
| Nooksack/Samish | 1% | | 1,066 | 79,501 | 20,800 | | 282% |
| Skagit | 1% | | 252 | 46,071 | 40,000 | | 15% |
| Stillaguamish | 0% | | 46 | 34,964 | 13,100 | | 167% |
| Snohomish | 0% | | 239 | 35,583 | 10,200 | | 249% |
| South Sound | 7% | | 36,912 | 441,499 | 64,350 | | 586% |
| Hood Canal | | | 360 | 99,621 | 39,900 | | 150% |
| Juan de Fuca | 2% | | 2 | 2,722 | 3,600 | | -24% |
| ***All Fall Chum*** | | | **38,877** | **739,961** | | | |

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-14b Performance of Alternative 4 (No Fishing) relative to Alternative 1 for coho, sockeye, pink, and chum salmon.

| | Changes Relative to Alternative 1 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Wild Exploitation Rate | Southern U.S.Catch | Total Mortality | Natural Escapement | % Change Escapement | Type of Impact | Magnitude of Impact |
| **Coho** | | | | | | | |
| Nooksack/Samish | -43% | (38752) | (7,185) | 7,123 | 87% | beneficial | substantial |
| Skagit | -31% | (36084) | (36,715) | 36,398 | 49% | beneficial | substantial |
| Stillaguamish | -29% | (6864) | (10,969) | 10,823 | 45% | beneficial | substantial |
| Snohomish | -25% | (74810) | (51,002) | 50,193 | 37% | beneficial | substantial |
| South Sound | -49% | (232599) | (51,361) | 50,718 | 108% | beneficial | substantial |
| Hood Canal | -35% | (9023) | (11,473) | 11,333 | 60% | beneficial | substantial |
| Juan de Fuca | -8% | (8402) | (1,529) | 1,499 | 9% | beneficial | low |
| ***All Coho*** | | **(406534)** | **(170234)** | **168087** | 52% | | |
| | | | | | | | |
| **Sockeye** | | | | | | | |
| Skagit | | (250) | | 250 | | | |
| South Sound | | (92600) | | (67,494) | | | |
| ***All Sockeye*** | | **(92850)** | | **250** | | | |
| | | | | | | | |
| **Pink** | | | | | | | |
| Nooksack/Samish | | (7184) | (7,184) | 7,184 | 8% | beneficial | low |
| Skagit | | (184614) | (184,611) | 184,614 | 43% | beneficial | substantial |
| Stillaguamish | | (90690) | (90,690) | 90,690 | 55% | beneficial | substantial |
| Snohomish | | (101193) | (101,192) | 101,193 | 58% | beneficial | substantial |
| South Sound | | (1319) | (1,313) | 1,313 | 10% | beneficial | low |
| Hood Canal | | (27008) | (7,597) | 27,322 | 136% | beneficial | substantial |
| Juan de Fuca | | (1490) | (1,490) | 1,490 | 31% | beneficial | substantial |
| ***All Pink*** | | **(413498)** | **(394077)** | **413806** | 46% | | |
| | | | | | | | |
| **Fall Chum** | | | | | | | |
| Nooksack/Samish | | (53672) | (43,891) | 43,891 | 123% | beneficial | substantial |
| Skagit | | (4001) | (3,834) | 3,834 | 9% | beneficial | low |
| Stillaguamish | | (21531) | (20,564) | 20,564 | 143% | beneficial | substantial |
| Snohomish | | (54045) | (17,983) | 17,983 | 102% | beneficial | substantial |
| South Sound | | (324346) | (290,576) | 290,576 | 193% | beneficial | substantial |
| Hood Canal | | (218627) | (49,240) | 49,239 | 98% | beneficial | substantial |
| Juan de Fuca | | (135) | (137) | 137 | 5% | beneficial | low |
| ***All Fall Chum*** | | **(676,357)** | **(426,225)** | **426,224** | 136% | | |

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003

Fall and winter chum salmon harvest under Alternative 4 is predicted to be about 39,000, a decrease relative to Alternative 1 of 676,357. Escapements of naturally-spawning fall and winter chum salmon are predicted to increase substantially – by 426,224 fish under Alternative 4, or more than 100 percent of the escapement goals for the Nooksack, Stillaguamish, Snohomish, Mid-Hood Canal, and South Puget Sound units. However, it is predicted that the escapement goal for the Strait of Juan de Fuca unit, for which the run size entering Puget Sound is predicted to be below the escapement goal, would not be achieved (see Table 4.3-14b).

Based on the predicted increases in escapement of naturally-spawning fish that would occur under Alternative 4 relative to Alternative 1, the impact of Alternative 4 on escapements of sockeye salmon, Nooksack-Samish and South Sound pink salmon, and Skagit and Strait of Juan de Fuca chum salmon are predicted to be beneficial, but of low magnitude. Impacts to all other populations of coho, fall-winter chum, and pink salmon are predicted to be substantially beneficial. However, as discussed above, escapement far in excess of current escapement goals raises the potential of intra- and inter-specific density-dependent reductions in productivity due to competition for mates, food or territory. For many coho salmon management units, exploitation rate objectives are based on stock recruit functions which would predict that large increases in escapement would not result in substantial increases in progeny (personal communication via e-mail from William Beattie, Northwest Indian Fisheries Commission, Conservation Management Coordinator, to The William Douglas Company, February 17, 2004).

### 4.3.3 Non-Salmonid Fish Species

Unlisted non-salmonid fish species potentially affected by the Proposed Action include the groundfish and forage fish species discussed in Subsections 3.3.3, Non-Salmonid Fishes (Groundfish): Affected Environment, and 3.3.4, Forage Species (Pacific Herring, Sandlance, Smelt): Affected Environment. Impacts of the Proposed Action or alternatives to groundfish species would result from changes in the incidental catch of these species in marine salmon fisheries. Impacts to forage fish species would be related to possible changes in the predator-prey relationship resulting from changes in the marine abundance of salmon.

According to Palsson (2002), marine salmon anglers take approximately 0.65 groundfish per trip. Therefore, with Alternative 1, the incidental catch of groundfish species in sport salmon fisheries is predicted to be approximately 241,765 groundfish, based on the area-wide average catch per trip. Species comprising the recreational catch include Pacific halibut, other flatfish, lingcod, rockfish

(*Sebastes spp.),* Pacific cod, and dogfish, but the species composition of groundfish caught incidentally during salmon fishing has not been quantified. Under Alternative 1, it is likely that sportfishing effort would vary somewhat under the different scenarios, but it is difficult to predict how that variability would affect the incidental catch of groundfish.

Under Alternative 2, 3, or 4 there would be no marine sport fisheries in Puget Sound, so incidental catch of groundfish would be reduced by 100 percent with either of these alternatives. As discussed in Subsection 3.3.3, commercial fisheries targeting salmon attempt to avoid incidental harvest of groundfish species, and landings of groundfish species in commercial salmon fisheries are rarely reported.

Under Alternative 2, most commercial salmon fisheries in marine areas would be closed (the marine fisheries that would occur under Alternative 2 are nearshore using beach seines or set gillnets and therefore are anticipated to have a negligible impact on groundfish), and under Alternative 3 or 4, all commercial salmon fisheries in marine areas would be closed. Therefore, incidental catch of groundfish under either of these alternatives would be eliminated relative to Alternative 1. This would represent a substantial beneficial impact to these species. Chinook and coho salmon are key predators of sandlance, herring, and smelt, the predominant forage fish species present in Puget Sound. Sockeye, chum and pink salmon, particularly as juveniles, feed predominately on small, free-swimming crustacea, but adults occasionally feed on forage fish species. The direct impacts of the Proposed Action or alternatives would be related to reductions in catch under Alternative 2, 3, or 4 that would potentially increase predation by adult salmon on these forage fish species during the period in which fisheries would otherwise take place. Other effects would be indirect in nature, and are discussed below in Subsection 4.3.8, Indirect and Cumulative Effects.

### 4.3.4 Fish Habitat

The primary impacts of salmon fisheries on fish habitat occur as a result of tribal and sport fisheries in river areas, and include disruptions of spawning beds by wading fishermen and boat traffic, and, to a lesser extent, degradation of streamside habitat. As required by the Magnuson-Steven's Conservation and Management Act, NMFS conducted an essential fish habitat (EFH) consultation on the 2003 4(d) determination and concluded that Alternative 1 (the Proposed Action) would not adversely affect designated EFH for chinook salmon. NMFS is currently conducting an EFH consultation on the ~~2004~~ 2005~~–~~2009 4(d) determination that will be complete for the Final Environmental Impact Statement. However, since the anticipated fishery structure of the Proposed Action is similar to that of the 2003 fisheries Resource Management Plan, the effects on EFH are also likely to be similar. Therefore, at this time, NMFS does not anticipate Alternative 1 will adversely affect designated EFH. Fisheries modeled under Alternatives 2 and 3 are predicted to increase the level of fishing effort in freshwater areas and, potentially, would result in a possible low adverse impact on fish habitat. Fisheries modeled under Alternative 4 are predicted to decrease fishing effort in freshwater areas relative to Alternative 1, and are therefore predicted to eliminate the potential impact to fish habitat from these sources and would thus be considered to have a no to low beneficial impact. However, regardless of the alternative considered, these effects would occur to some degree through the occurrence of fisheries other than those addressed in Alternative 1 (the Proposed Action); e.g., recreational freshwater trout or steelhead fisheries, that do not take listed Puget Sound salmon species.

### 4.3.5 Marine-Derived Nutrients from Spawning Salmon

The input of nutrients into freshwater systems associated with the return of adult salmon is, at the simplest level, directly related to the biomass of spawners of all species. However, as described in Affected Environment (Subsection 3.3.6, Marine-Derived Nutrients from Spawning Salmon), the processes by which juvenile chinook and other species benefit directly and indirectly from this source of nutrients comprise a highly complex transport web.

~~Nutrients provided by adult salmon to freshwater systems are, at the simplest level, directly related to the biomass of spawners of all species. However, as described in the Affected Environment (Subsection 3.3.5, Marine-Derived Nutrients from Spawning Salmon), highly complex processes determine how juvenile chinook salmon and other species benefit directly and indirectly from this source of nutrients.~~

This subsection refers to the modeled spawning escapement of all salmon species, converted to carcass biomass predicted to result from implementation of the Proposed Action or alternative harvest management regimes, and assesses the nutrient-related effects on the production and survival of juvenile chinook. At the current state of scientific inquiry in this field, variability in the factors affecting salmon-derived nutrient loading; and the state of technical tools necessary to quantify nutrient loading, it is not possible to quantify nutrient loading in any one Puget Sound river system, or to measure the differences in growth and survival of juvenile chinook in a system that would result from different spawner abundance of all salmon species.

~~in any one Puget Sound river system, or the differences in growth and survival of juvenile chinook in a system that would result from different spawner abundance of all salmon species, are not available.~~

~~Nutrient loading is affected by spawner density, which varies greatly among species and river reaches, and by stream flow, water temperature, stream channel structure, and a multitude of other factors that affect carcass and nutrient availability, decomposition, and retention (see Subsection 3.3.5, Marine-Derived Nutrients from Spawning Salmon: Affected Environment).~~

The following analysis compares adult salmonid escapement and spawner biomass among alternatives for Scenario B, because this scenario is the most likely combination of chinook abundance and fisheries to occur over the duration of the Proposed Action. The variability in escapement associated with the other Canadian/Alaskan fishery and abundance scenarios (A, C, or D) is noted, but does not influence the relative magnitude of the potential impact of the alternatives.

It must be noted that added nutrients, above current levels, may not be desirable in all streams. The Washington Department of Ecology reports that more than 2,600 bodies of water throughout Washington are listed under Section 303(d) of the Clean Water Act as Category 5, “polluted.” For those waters, and others with lesser water quality problems, increased nutrient loads may not provide a benefit to fish and wildlife. Lackey (2003) reminds us that federal and state legislation has, for many years, focused on reducing the nutrient and toxic pollutant input associated with human development, so intentionally managing salmonids to increase nutrient input has complex implications for public policy.

#### 4.3.5.1 Alternative 1 – Proposed Action/Status Quo

To compare the consequences of the Proposed Action or alternatives, the biomass of spawning salmon is compared for ~~four~~ three river systems – the Skagit River, Snohomish River, and Stillaguamish River~~, and the Green-Duwamish River~~. These systems offer examples that contrast the variation in total spawner biomass in different systems, and the contribution of chinook salmon to total spawner biomass. For this analysis, biomass was approximated from modeled escapements and average weights for each species (i.e., 15 pounds for chinook, 12 pounds for chum, 6 pounds for coho, and 4 pounds for pink salmon) (personal communication with Robert Hayman, Skagit Systems Cooperative, Salmon Recovery Biologist, August 19, 1999). Sockeye salmon are not included in this accounting, because they spawn only in the Baker River drainage of the Skagit basin and in the Cedar River (Lake Washington system), and therefore are not broadly representative of the species composition in Puget Sound watersheds with spawning salmon. Salmon escapement in other river systems in Puget Sound varies from that in the three example watersheds. Pink salmon are not generally abundance, except in the Nooksack River, and recently in the Green River, whereas chum salmon are widely distributed and spawn in large and small river and stream systems.

Under Alternative 1, the co-managers’ proposed harvest plan, total spawner biomass is projected to exceed 2.86 million pounds in the Skagit River system, 1.80 million pounds in the Snohomish River system, and 1.01~~0~~ million pounds in the Stillaguamish River system~~, and 0.15 million pounds in the Green-Duwamish River system~~ (Table 4.3.5-1). In the Skagit, Stillaguamish, and Snohomish River systems, chinook salmon contribute a small proportion (i.e., 4% to 7%) of the total biomass, while coho, pink, and chum salmon each comprise much larger proportions. ~~By contrast, in the Green-Duwamish River, coho and chum salmon escapement is relatively low, but chinook salmon comprise 59 percent of total spawner biomass.~~ Hatchery-origin chinook salmon comprise a relatively small proportion of chinook salmon escapement ~~to~~in the Skagit~~, Stillaguamish,~~ and Snohomish River systems~~, but a large proportion of chinook salmon escapement to the Green-Duwamish River system,~~ but have contributed up to 55 percent in the North Fork of the Stillaguamish River. Chinook spawning escapement is predicted to vary from 3 percent higher to 24 percent lower than Scenario B[xiii], if abundance and Canadian/Alaskan fisheries varies as specified in Scenarios A, C, or D. Total spawning escapement would also vary with changes in overall abundance and Canadian/Alaskan fisheries harvest levels, but information is not currently available to quantify the amount.

Table 4.3.5-1 Biomass (pounds) of spawning salmon in the Skagit, Snohomish, and ~~Green r~~Stillaguamish Rivers, under Alternative 1.

| | Chinook | Coho | Pink | Chum | Total |
|---|---|---|---|---|---|
| Skagit | 193,104 | 441,744 | 1,723,168 | 506,840 | 2,864,856 |
| Snohomish | 73,511 | 821,238 | 692,000 | 211,200 | 1,797,949 |
| Stillaguamish | 34,215 | 144,102 | 656,000 | 172,800 | 1,007,117 |

| ~~Chinook~~ | ~~Coho~~ | ~~Pink~~ | ~~Chum~~ | ~~Total~~ |
|---|---|---|---|---|
| ~~203,310~~ | ~~441,744~~ | ~~1,723,168~~ | ~~506,840~~ | ~~2,875,061~~ |
| ~~76,089~~ | ~~821,238~~ | ~~692,000~~ | ~~211,200~~ | ~~1,800,527~~ |
| ~~87,285~~ | ~~42,377~~ | ~~0~~ | ~~18,111~~ | ~~147,773~~ |
| ~~34,830~~ | ~~144,102~~ | ~~656,000~~ | ~~172,800~~ | ~~1,007,732~~ |

The extent to which these escapements promote or constrain the productivity of natural chinook salmon populations cannot be quantified, due to factors discussed above and the lack of basin-specific empirical understanding of the relationship between escapement, nutrient loading, and salmon productivity. Intuitively, any factor that increases the growth rate of juvenile chinook salmon could, potentially, increase their survival through their freshwater, estuarine, and early marine life stages, but this effect has not been empirically demonstrated for Puget Sound chinook. Chinook populations that characteristically produce high proportions of yearling smolts will be more likely to benefit, given their

[xiii] Spawning escapements projected to occur under Alternative 1 may vary substantially from the example provided above for some systems in some years. In the Skagit system, for example, total spawner biomass ranged from 1.0 to 5.2 million pounds in 1998 – 2002 (personal communication with Robert Hayman, Skagit River System Cooperative, August 2003). Units for which harvest is managed under exploitation rate objectives are predicted to experience variable escapement, increasing or decreasing in direct relation to total abundance. For some units managed under escapement goals, recent experience suggests that escapement may also exceed goals depending on abundance, but less so than under exploitation rate management since all abundance above the goal is considered available for harvest.

extended freshwater residence, as is predicted to juvenile coho salmon and steelhead, all of which reside in freshwater for more than one year before smolting. However, ocean-type chinook populations, and pink and chum salmon, might also benefit from increased nutrient loading, particularly if it increases prey availability in estuarine areas.

If nutrient loading currently imposes a primary constraint on juvenile salmon survival, then the consequences of Alternative 1 are predicted to maintain the status quo in this regard. If production and availability of the ~~Nutrient-related constraint of productivity rests on the assumption that the~~ preferred prey of juvenile coho salmon is limited by current nutrient loading from salmon carcasses~~such that, at some point in their early life history~~, the growth and survival of juvenile salmon is reduced under current conditions. This hypothesis is supported for some salmon species by numerous studies that consistently show increased growth rates among juvenile coho and steelhead when carcass loading is increased (Bilby et al. 1998; and Wipfli et al. 1999). However, information is insufficient to identify in which populations of Puget Sound chinook, or other salmon species, survival might be affected.

If habitat conditions or other physical and biotic factors currently limit survival, maintaining recent escapements will have little or no effect on chinook productivity. For example, circumstantial evidence suggests this is the case in the Skagit River. The magnitude of peak river flow during the chinook incubation period, presumably due to increased risk of scour and sediment deposition in spawning areas, has correlated very closely with ~~Age-0~~ chinook smolt production (Seiler et al. 2002 and 2000). There is no odd-even year pattern of chinook smolt abundance or survival rate, as is predicted to be expected if the observed variation in pink salmon carcass loading affected chinook survival. Though such an effect is predicted to be statistically difficult to detect, given the overwhelming influence of incubation period flow, there is no significant correlation between chinook salmon smolt abundance and escapement of other species, even when the effects of flow are taken into account (personal communication with Robert Hayman, Skagit River System Cooperative, Salmon Recovery Planner, August 19, 1999).

This hypothesis will continue to be tested when the productivity of systems in which salmon escapement has recently increased substantially is reassessed. Under Alternative 1, such monitoring is required, and adjustment of management objectives is mandated, if studies determine that the productivity of chinook or other salmon species is nutrient-limited.

Implementation of Alternative 1 would also maintain current conditions among the wide variety of other aquatic and terrestrial species that feed directly on carcasses or utilize marine derived nutrients. Because the abundance of returning salmon varies annually, their potential nutrient contribution will also vary over the short term from the baseline level examined in this assessment. Direct consumers of carcasses – aquatic invertebrates, fish, mammals, and birds – will experience this annual fluctuation in abundance, whereas indirect plant or animal consumers will be less affected because these nutrients are stored and re-cycled within the local trophic web. This assessment cannot practically examine the range of possible effects of Alternative 1 on all fish and wildlife species that utilize marine derived nutrition. Ignoring, for the moment, the likelihood of annual variation in salmon escapement, the current level of carcass nutrient will persist under Alternative 1, so major changes in the distribution and abundance of consumer species is not anticipated.

#### 4.3.5.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Under Alternative 2, Scenario B, total salmon spawner biomass is predicted to be 3.91 million pounds in the Skagit River (37~~6~~% higher than with Alternative 1), 1.84 million pounds in the Snohomish system (2% higher than with Alternative 1), and 1.40 million pounds in the Stillaguamish River system (39% higher than with Alternative 1)~~, and 0.20 million pounds in the Green-Duwamish River system (34% higher than with Alternative 1)~~ (Table 4.3.5-2)[xiv].

Assuming no scouring floods and sufficient carcass retention time, a broader distribution of carcasses throughout the river system might enhance primary and secondary ~~local~~ production (e.g., increase the production of aquatic algae, some riparian plant species, and invertebrate consumers at lower trophic levels)~~vity~~. Detailed analysis of spawner distribution is not available for this assessment; however, it may be possible that the predominant abundance of pink and chum spawners is predicted to be sufficient to supply the nutrients essential to the production of salmon prey species. This assumes that the carcasses are retained, and that marine-derived nutrients drive production of prey in habitat that is utilized by juvenile chinook salmon. However, increase in spawner abundance~~presence of carcasses~~, and resultant higher productivity, might ~~be inhibited by~~not result in higher survival of juvenile salmon if other habitat factors, such as incubation period flows or the availability of suitable spawning or rearing habitat limits survival. If, on the other hand, habitat is not limiting, Alternative 2 could have a beneficial effect on nutrient loading and subsequent production. ~~Therefore, a~~Although spawner biomass is predicted to be substantially higher with Alternative 2 compared to Alternative 1 for all ~~of~~

[xiv] Note, however, that these increases in total spawner biomass, comprise fewer spawners of some species (e.g., fewer chinook and/or coho in the Stillaguamish and Snohomish systems). Because species are distributed differently in the watersheds, their nutrient inputs, and effects, will not be equal, pound for pound.

three ~~the four~~ of the example systems, it is not possible for these reasons to predict the difference in effects on the productivity of chinook salmon or other species.

Table 4.3.5-2 Biomass (pounds) of spawning salmon in the Skagit, Snohomish, and ~~Green~~ Stillaguamish ~~r~~Rivers, under Alternative 2.

| | Chinook | Coho | Pink | Chum | Total |
|---|---|---|---|---|---|
| Skagit | 239,163 | 659,322 | 2,461,623 | 552,851 | 3,912,959 |
| Snohomish | 69,046 | 244,914 | 1,096,771 | 426,993 | 1,837,725 |
| Stillaguamish | 13,560 | 172,134 | 801,439 | 410,333 | 1,397,467 |

| ~~Chinook~~ | ~~Coho~~ | ~~Pink~~ | ~~Chum~~ | ~~Total~~ |
|---|---|---|---|---|
| ~~250,956~~ | ~~659,322~~ | ~~2,461,623~~ | ~~552,851~~ | ~~3,924,752~~ |
| ~~82,123~~ | ~~1,122,396~~ | ~~1,096,771~~ | ~~426,993~~ | ~~2,728,284~~ |
| ~~87,000~~ | ~~62,951~~ | ~~0~~ | ~~47,971~~ | ~~197,922~~ |

| | | | | |
|---|---|---|---|---|
| ~~37,020~~ | ~~209,040~~ | ~~1,018,762~~ | ~~419,565~~ | ~~1,684,387~~ |

For chinook salmon populations that would be managed under exploitation rate objectives with Alternative 1 (i.e., the Skagit, Stillaguamish, and Snohomish management units), changing to escapement goal management is predicted to result in more stable numbers of spawners, provided that these goals were consistently achieved. This outcome is predicted to depend on accurate forecasting methods and low management error (see Subsection 4.3.8, Indirect and Cumulative Effects). The objectives for populations for which harvest is already managed to achieve escapement goals is predicted to not change with Alternative 2, but under the Puget Sound chinook abundance scenarios considered by this review, escapement goal management is predicted to virtually preclude marine harvest. Spawning escapement relative to Alternative 1 is predicted to increase as a result, particularly where terminal fisheries could not completely harvest the surplus of all species.

The abundance and production of other aquatic and terrestrial species that feed directly on salmon carcasses and eggs, or utilize marine-derived nutrients, is likely to increase under Alternative 2. Higher spawner abundance will increase the local abundance of avian and mammalian predators, as they are attracted to spawning streams. Many studies (see Subsection 3.3.6) indicate that production of aquatic invertebrates will increase, and provide more food for their predators. Effects could be manifest as increased over-winter survival and increased productivity in subsequent years for many species. Quantifying these effects is not possible in this assessment, because baseline abundance and production, or increase, has not been measured at the watershed or population scale for affected species. Again, this conclusion rests on the assumption that other environmental factors not constraining their survival and production.

### 4.3.5.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

The spawning biomass for all species of salmon, and resultant nutrient loading, is predicted to increase substantially relative to Alternative 1, if Alternative 3 were implemented. Under Alternative 3, total biomass of spawning salmon is predicted to be 3.91 million pounds, or 36 percent higher in the Skagit River system~~, –~~, 2.73 million pounds or 52 percent higher in the Snohomish River system, and 1.68 million pounds, or 67 percent higher in the Stillaguamish River system~~, and 34 percent higher in the Green-Duwamish River system~~, relative to Alternative 1 (Table 4.3.5-3). ~~As with Alternative 2,~~T~~ the contribution of chinook salmon to total nutrient loading is predicted to be slightly less than with Alternative 1, because the virtual closure of all marine-area fisheries is predicted to result in proportionately greater escapement of other species~~hese total biomass estimates comprise higher escapement levels of all species in each of the three example rivers than under Alternative 1, but particularly higher abundance of coho, pink and chum salmon.

The effect of the projected increase in total salmon escapement on the productivity of chinook or other salmon species in these example systems, or within the Puget Sound ESU in general, cannot be quantified with current information due to the degree of variability in the environmental factors discussed above. As described above, juvenile chinook salmon with extended freshwater rearing (particularly those that smolt as yearlings) are predicted to be more likely to benefit from Alternative 3. But the nutrient loading (i.e., carcass density) thresholds necessary to support optimal primary and secondary productivity have not been determined for any Puget Sound basin. Therefore, the consequences to individual populations of implementing Alternative 3 are unknown, and are predicted to vary among different river systems. Also, if current habitat conditions create a primary constraint on system capacity and productivity, any beneficial effects of increased spawner abundance and nutrient loading may be offset by increased competition for suitable spawning habitat, redd superimposition, or overcrowding of rearing habitat. If, on the other hand, habitat is not limiting, Alternative 3 could have a beneficial effect on nutrient loading and subsequent production. Therefore, although spawner biomass is predicted to be substantially higher compared to Alternative 1 for all ~~four~~ three of the example systems, it is not possible for these reasons to predict the difference in effects on the productivity of chinook salmon or other species.

Table 4.3.5-3 Biomass (pounds) of spawning salmon in the Skagit, Snohomish, and ~~Green~~ Stillaguamish ~~r~~Rivers, under Alternative 3.

| | Chinook | Coho | Pink | Chum | Total |
|---|---|---|---|---|---|
| Skagit | 239,182 | 659,322 | 2,461,623 | 552,851 | 3,912,978 |
| Snohomish | 80,514 | 1,122,396 | 1,096,771 | 426,993 | 2,726,675 |
| Stillaguamish | 36,690 | 209,040 | 1,018,762 | 419,565 | 1,684,057 |

The beneficial effects of implementing Alternative 3 on other aquatic and terrestrial species cannot be quantified, but the qualitative effects, discussed under Alternative 2 above, might also result under Alternative 3.

| ~~Chinook~~ | ~~Coho~~ | ~~Pink~~ | ~~Chum~~ | ~~Total~~ |
|---|---|---|---|---|
| ~~250,937~~ | ~~659,322~~ | ~~2,461,623~~ | ~~552,851~~ | ~~3,924,734~~ |
| ~~69,514~~ | ~~244,914~~ | ~~1,096,771~~ | ~~426,993~~ | ~~1,838,192~~ |
| ~~87,000~~ | ~~62,951~~ | ~~0~~ | ~~47,971~~ | ~~197,922~~ |
| ~~13,545~~ | ~~172,134~~ | ~~801,439~~ | ~~410,333~~ | ~~1,397,452~~ |

### 4.3.5.4 Alternative 4 – No Action/No Authorized Take

Preclusion of all fisheries that harvest listed chinook salmon, as envisioned under Alternative 4, is predicted to result in substantially higher spawning escapement of all salmon species, and possibly substantially higher nutrient loading than is predicted to occur with Alternative 1. Total spawner biomass in the three example river systems is predicted to be virtually identical to that predicted under Alternative 3, i.e., 37 percent higher in the Skagit River system, 52 percent higher in the Snohomish River system, and 67 percent higher in the Stillaguamish River system~~, and 98 percent higher in the Green-Duwamish River system~~, compared to Alternative 1 (Table 4.3.5-4).

As noted in the preceding discussion, the effects of higher spawner biomass cannot be assumed to increase the productivity of chinook or other salmon species. Increases in productivity are predicted to be expected where nutrient input now limits prey availability, with consequent effect on the growth and survival of juvenile salmon. Increase in survival is predicted to only be realized if other habitat constraints on survival were addressed. Competition for suitable spawning areas, and other density-dependent factors may also counteract the potential nutrient-related benefit to growth and survival of juvenile chinook salmon. Therefore, although spawner biomass is predicted to be substantially higher with Alternative 4 compared to Alternative 1 for all ~~four~~ three of the example systems, it is not possible for these reasons to predict the difference in effects on the productivity of chinook salmon or other species.

Table 4.3.5-4 Biomass (pounds) of spawning salmon in the Skagit, Snohomish, and ~~Green~~ ~~r~~Stillaguamish Rivers, under Alternative 4.

| | Chinook | Coho | Pink | Chum | Total |
|---|---|---|---|---|---|
| Skagit | 239,182 | 660,132 | 2,461,623 | 552,851 | 3,913,788 |
| Snohomish | 80,514 | 1,122,396 | 1,096,771 | 426,993 | 2,726,675 |
| Stillaguamish | 36,690 | 209,040 | 1,018,762 | 419,565 | 1,684,057 |

| ~~Chinook~~ | ~~Coho~~ | ~~Pink~~ | ~~Chum~~ | ~~Total~~ |
|---|---|---|---|---|
| ~~250,956~~ | ~~660,132~~ | ~~2,461,623~~ | ~~552,851~~ | ~~3,925,562~~ |
| ~~82,562~~ | ~~1,122,396~~ | ~~1,096,771~~ | ~~426,993~~ | ~~2,728,723~~ |
| ~~158,370~~ | ~~88,024~~ | ~~0~~ | ~~52,980~~ | ~~299,374~~ |

| | | | | |
|---|---|---|---|---|
| ~~37,020~~ | ~~209,040~~ | ~~1,018,762~~ | ~~419,565~~ | ~~1,684,387~~ |

### 4.3.6 Selectivity on Biological Characteristics of Salmon

Puget Sound fisheries regimes would vary substantially between the Proposed Action and alternatives considered in this Environmental Assessment, with respect to their selective effects on target species. This section qualitatively compares their effects, focusing on chinook salmon since that is the subject of the Proposed Action. It must be stated at the outset that a quantitative or theoretical analysis of the selective effects of current or historical fishing regimes has not been done in Puget Sound, except on a limited basis (Hard 2004 and as described in Subsection 3.3.7). As described in the Affected Environment (Subsection 3.3.7), long-time series of data describing the age composition and size of chinook salmon in catch and on the spawning grounds exist for many Puget Sound chinook salmon populations. However, the quality of the data vary greatly from population to population. Better data generally exist for returns to hatcheries. The causes for observed variation or trends in these biological characteristics are highly complex and confounded with each other, as discussed in Subsection 3.3.7. Although there is some indication that fisheries may be responsible for some proportion of the trends in size-at-age observed for some Puget Sound chinook populations, ~~T~~the influence of fisheries selectivity on variation and trends cannot be isolated from environmental and other causes. Furthermore, historical data reflect a constantly-changing fishing regime in fisheries inside and outside of Washington, particularly during the last decade (1991–2001). The selective effects of historically higher fishing pressure, for all gear types, are likely to have declined substantially as exploitation rates on Puget Sound chinook salmon have fallen (PSIT and Washington Department of Fish and Wildlife 2004). The relative harvest rates exerted by different gear types, and the distribution of effort by different gear types, have changed dramatically over the last 30 years. Furthermore, fishing regimes like those envisioned under Alternative 2 or 3 have never existed in Puget Sound, so their effects are necessarily a matter of conjecture.

Review of the scientific literature (discussed in Subsection 3.3.7) suggests that Puget Sound fisheries would exert some degree of selectivity on the size- or age-composition of chinook salmon, but available data do not indicate any changes or trends in the age composition of catch or escapement over the last several decades. As discussed in Subsection 3.3.7, the available data suggests that fisheries may exert some selective effects on some Puget Sound chinook populations, but do not indicate significant declines in size-at-age in the natural components of populations with moderate to high exploitation rates as might be expected. Hard (2004) concluded that selective effects over a 25 year period would be negligible or low at harvest rates less than approximately 40 percent. Further simulation with available data suggests that even for the hatchery components of populations with exploitation rates in excess of

50 percent and observed declines in size-at-age for ages most vulnerable to selective fishing effects, fisheries generally explain only a modest fraction of the observed trends (see Subsection 3.3.7). Exploitation rates on most chinook salmon populations associated with Puget Sound fisheries during the ~~period 2004~~ 2005–2009 fishing seasons are projected to fall well below this level in fishing regimes examined in this Environmental Impact Statement. The potential selective effects of fisheries will continue to be re-examined on a regular basis as part of the monitoring, evaluation, and adaptive management provisions of the Proposed Action or alternatives.

Since the pattern of exploitation rates across alternatives is similar for each scenario and cannot be quantitatively related to changes in size or age except on a very gross scale, the results have been combined across scenarios and are presented only by alternative for the purposes of the selective effects discussion.

#### 4.3.6.1 Alternative 1 – Proposed Action/Status Quo

The Proposed Action represents a diverse spatial and temporal array of commercial net and recreational hook-and-line fisheries in marine and freshwater areas of Puget Sound. Some net fisheries would operate in the Strait of Juan de Fuca, Rosario Strait, and the Strait of Georgia, where stocks originating in Puget Sound and British Columbia commingle. These fisheries target sockeye, pink, and chum salmon, and harvest relatively few chinook salmon. Non-treaty purse seine vessels are required to release chinook salmon, and seines are designed to reduce the catch of immature chinook. In aggregate, these fisheries are likely to exert relatively low selective effects on chinook salmon.

Gillnet fisheries predominate commercial harvest of chinook salmon in other marine and freshwater areas in Puget Sound; e.g., Bellingham Bay/Samish Bay, Skagit Bay/Saratoga Passage, Port Susan/Possession Sound, central and south Puget Sound, and Hood Canal. The selectivity of gillnet gear is directly related to the mesh size, which is commonly expressed as the stretched diagonal dimension. Fishing regulations specify the mesh dimension for each gillnet fishery; different mesh sizes are specified for each target species. Chinook-directed gillnet fisheries typically use 6½-inch mesh, which is ineffective in capturing the smallest and largest size classes of chinook salmon. Pink- and coho-directed salmon fisheries typically use smaller mesh (e.g., 5-inch), which captures fewer large chinook, and a larger number of smaller chinook salmon. Capture efficiency is also affected by many other factors, including ambient light, water clarity, net design (hanging), and current. ~~The size- or age-composition of chinook salmon before and after they encounter a net fishery has not been experimentally compared in Puget Sound, so the vulnerability of different ages or sizes of chinook salmon has not been quantified.~~

Each year, Puget Sound fisheries during the ~~period 2004~~ 2005–2009 fishing seasons will harvest varying proportions of five cohorts of chinook salmon (i.e., Age-2, 3, 4, 5, and 6 fish). During that period, Puget Sound fisheries will affect the dominant age classes of five brood cycles (brood years 2001–2005). As discussed in Subsection 3.3.7, the majority of harvest will be of Age-3 to Age-5 fish, with Age-4 fish comprising the largest proportion. The primary concern is that Puget Sound fisheries might remove a large proportion of older, larger chinook salmon, or chinook that, if not harvested, would be larger and older at maturity, and that depleted of these age and size classes, spawners that escape fisheries would be less productive. However, the magnitude of the immediate effect on the cohorts of a population that are vulnerable to fishing in a given year will depend on fishing pressure (exploitation rate) and how the fishing season is structured. Under Alternative 1, annual exploitation rates would range from 17 to 76 percent on Puget Sound chinook management units depending on the scenario; rates would be below 40 percent for 10 of the 15 management units (Table 4.3.6.1-1). Southern U.S. exploitation rates would range from 5 to 68 percent depending on the scenario and management unit; rates would be below 40 percent for twelve of the fifteen management units (Table 4.3.6.1-1). For most natural units, then, under Alternative 1, two-thirds of the management units would experience total exploitation rates below the level where selective effects might occur (Hard 2004). Only three management units (Green-Duwamish, Nisqually and Skokomish) would experience exploitation rates above this level directly as a result of southern U.S. fisheries (primarily in Puget Sound) (Table 4.3.6.1-2). Commercial fisheries would not operate continuously through the fishing season. In most fishing areas, commercial openings would be scheduled for one to three days per week. This *pulsed* schedule is designed to distribute harvest mortality and escapement across the entire migration timing of the population(s) present in that area. Recreational fisheries would generally open for longer periods, though effort is expected to be much higher on weekends and holidays. Recreational fisheries that target immature chinook salmon in the winter and spring (November through April) would be open for intermittent month-long periods (i.e., they would not operate continuously for 6 months).

If the Alternative 1 fisheries regime were implemented for the ~~2004~~ 2005–2009 ~~management years~~fishing seasons, it would be expected to exert minor changes to the age and size composition of most Puget Sound chinook salmon populations that, absent fishing, would spawn naturally. Each year, the fishery will influence the age and size composition of spawners in that year, and in three or four subsequent years (i.e., when the youngest cohort contributing to that year's fishery matures). As a result, fisheries implemented under Alternative 1 during the ~~2004~~ 2005–2009 fishing seasons would affect the dominant age classes of five brood cycles (brood years ~~2001~~ 2002–2005). Similarly, the composition of spawners in ~~2004~~ 2005–~~2006~~2009 will have already been influenced by fisheries prior to ~~2004~~ 2005. If, as some studies assert, the productivity of a given population is, under adverse freshwater conditions, more dependent on the higher fecundity and spawning success (i.e., number of fertilized eggs per female) of older, larger fish, then the productivity of the period ~~2004~~ 2005–2009 broods might be lower as a result of fishing. Data are not available to estimate the magnitude of the short-term effect (i.e., the reduction in recruits per spawner for, say, the ~~2004~~ 2005 brood) for any of the affected broods, nor has it been estimated empirically for any previous brood year. Smolt production is strongly influenced by complex environmental factors, and is particularly sensitive to the magnitude of high flows during the incubation season (Seiler et al 2000). Though redds constructed by older or larger females may be somewhat less vulnerable to high flow, the reduction in productivity implied by a slightly lower proportion of older spawners cannot be estimated in the face of high uncertainty about flow conditions that will prevail in the winters of ~~2004~~ 2005–2010.

Further circumstantial evidence suggests that the long-term selective effects of fisheries are predicted to be minor, if not undetectable. The average fecundity of mature Skagit River summer chinook salmon has not declined from 1973 to the present (Orrell 1976; and SSC 2002). The age composition of Skagit River summer/fall chinook salmon harvested in the terminal area has varied widely over the last 30 years, particularly with respect to the proportions of Age-3 and Age-4 fish, but there is no declining trend in the contribution of Age-5 fish, which has averaged 15 percent (Henderson and Hayman 2002; and R. Hayman, Skagit Systems Cooperative December 9, 2002, personal communication).

As described in Subsection 3.3.7, no decline in average age has been detected for other Puget Sound chinook salmon populations for which data are available (Figure 3.3.7-2), including the Green-Duwaumish which commonly experienced fishery exploitation rates of 60 to 70 percent through the early 1990s. Collectively, the mixture of upward and downward observed trends in size-at-age for the Puget Sound chinook salmon populations analyzed, and the fact that the expected trends estimated by the harvest model generally explain only a modest fraction (<50%) of corresponding observed trends, suggest that environmental influences are large on the observed size trends. It was not possible from the present analysis to discriminate reliably between harvest and environmental effects on growth and size. Declining total exploitation rates on most natural chinook salmon stocks in Puget Sound in the last ten years (1991–2001) from averages of 70 to 90 percent to averages of 30 to 50 percent, due in part to decline in exploitation rates in Puget Sound fisheries, would suggest that selective pressure has also been reduced. Exploitation rates are expected to remain lower during implementation of the Proposed

Action. To the extent that effects have been detected, they would be expected to decrease under these lower rates unless the use of selective gear types increases.

In light of the information presented above, implementation of Alternative 1 is predicted to have a no to low negative effect on size and age as a result of the size-selective effects of fishing.

Table 4.3.6.1-1. Range of expected total exploitation rates by Puget Sound chinook management unit during the period ~~2004~~ 2005–2009.

| **Puget Sound Chinook** | **Alternative 1** | | **Alternative 2** | | **Alternative 3** | | **Alternative 4** | |
|---|---|---|---|---|---|---|---|---|
| (Management Unit/Population) | **minimum** | **maximum** | **minimum** | **maximum** | **minimum** | **maximum** | **minimum** | **maximum** |
| | | | | | | | | |
| Dungeness Spring | 0.22 | 0.29 | 0.19 | 0.26 | 0.19 | 0.26 | 0.19 | 0.26 |
| Western Strait-Hoko | 0.23 | 0.30 | 0.19 | 0.26 | 0.19 | 0.26 | 0.19 | 0.26 |
| Elwha | 0.22 | 0.30 | 0.19 | 0.26 | 0.19 | 0.26 | 0.19 | 0.26 |
| Nooksack Spring | 0.20 | 0.26 | 0.14 | 0.20 | 0.14 | 0.20 | 0.14 | 0.20 |
| Skagit | | | | | | | | |
| Spring | 0.23 | 0.28 | 0.12 | 0.17 | 0.12 | 0.17 | 0.12 | 0.17 |
| Upper Sauk | | | | | | | | |
| Suiattle | | | | | | | | |
| Upper Cascade | | | | | | | | |
| Summer/Fall | 0.48 | 0.56 | 0.32 | 0.43 | 0.32 | 0.43 | 0.32 | 0.43 |
| Lower Sauk | | | | | | | | |
| Upper Skagit | | | | | | | | |
| Lower Skagit | | | | | | | | |
| Stillaguamish | 0.17 | 0.20 | 0.52 | 0.67 | 0.08 | 0.11 | 0.08 | 0.11 |
| Snohomish | 0.19 | 0.23 | 0.10 | 0.23 | 0.10 | 0.13 | 0.09 | 0.13 |
| Lake Washington | 0.31 | 0.38 | 0.18 | 0.25 | 0.18 | 0.25 | 0.18 | 0.25 |
| Green-Duwamish | 0.49 | 0.63 | 0.36 | 0.56 | 0.36 | 0.56 | 0.18 | 0.25 |
| Puyallup | 0.49 | 0.50 | 0.57 | 0.71 | 0.57 | 0.71 | 0.18 | 0.25 |
| Nisqually | 0.64 | 0.76 | 0.61 | 0.73 | 0.61 | 0.73 | 0.16 | 0.23 |
| White Spring | 0.20 | 0.20 | 0.22 | 0.46 | 0.22 | 0.46 | 0.02 | 0.03 |
| Mid-Canal | 0.26 | 0.34 | 0.19 | 0.28 | 0.19 | 0.28 | 0.19 | 0.28 |
| Skokomish | 0.45 | 0.63 | 0.43 | 0.61 | 0.43 | 0.61 | 0.19 | 0.28 |

Exploitation rates greater than 0.4 are shaded.

Table 4.3.6.1-2. Range of expected southern U.S. exploitation rates by Puget Sound chinook management unit during the period ~~2004~~ 2005–2009.

| **Puget Sound Chinook** (Management Unit/Population) | **Alternative 1** | | **Alternative 2** | | **Alternative 3** | | **Alternative 4** | |
|---|---|---|---|---|---|---|---|---|
| | **minimum** | **maximum** | **minimum** | **maximum** | **minimum** | **maximum** | **minimum** | **maximum** |
| Dungeness Spring | 0.05 | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Western Strait-Hoko | 0.05 | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Elwha | 0.05 | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Nooksack Spring | 0.07 | 0.07 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Skagit | | | | | | | | |
| Spring | 0.14 | 0.15 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Upper Sauk | | | | | | | | |
| Suiattle | | | | | | | | |
| Upper Cascade | | | | | | | | |
| Summer/Fall | 0.16 | 0.18 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 |
| Lower Sauk | | | | | | | | |
| Upper Skagit | | | | | | | | |
| Lower Skagit | | | | | | | | |
| Stillaguamish | 0.11 | 0.12 | 0.43 | 0.60 | 0.02 | 0.02 | 0.02 | 0.02 |
| Snohomish | 0.13 | 0.14 | 0.03 | 0.16 | 0.10 | 0.13 | 0.03 | 0.03 |
| Lake Washington (Cedar River | 0.20 | 0.23 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Green-Duwamish | 0.36 | 0.51 | 0.18 | 0.42 | 0.18 | 0.42 | 0.05 | 0.05 |
| Puyallup | 0.35 | 0.39 | 0.39 | 0.57 | 0.39 | 0.57 | 0.05 | 0.05 |
| Nisqually | 0.53 | 0.68 | 0.47 | 0.63 | 0.47 | 0.63 | 0.07 | 0.08 |
| White Spring | 0.17 | 0.19 | 0.20 | 0.46 | 0.20 | 0.46 | 0.01 | 0.01 |
| Mid-Canal | 0.12 | 0.13 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Skokomish | 0.26 | 0.50 | 0.23 | 0.46 | 0.23 | 0.46 | 0.05 | 0.05 |

Exploitation rates greater than 0.4 are shaded.

### 4.3.6.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Implementation of Alternative 3 for the ~~2004~~ 2005–2009 ~~management years~~fishing seasons would preclude marine net and recreational fisheries in Puget Sound except for a small marine net fishery in Tulalip Bay, and substantially reduce exploitation rates on most chinook salmon natural management units. The size-selective effects of pre-terminal net fisheries predicted to occur under Alternative 1, would not occur. Except for the limited Tulalip Bay fishery, gillnet fishery effects would be confined to those associated with in-river fisheries, and further confined to fisheries directed at other species in most rivers. The selective effects of recreational fisheries, which with Alternative 1 would operate under a 22-inch minimum size restriction, would also be eliminated.

The consequences of implementing Alternative 2, however, cannot be quantified in terms of a change in the age- or size-composition of chinook spawners during the period 200~~4~~5–2009. Though exploitation rates would be lower for most populations relative to Alternative 1, these would be declines from already-low rates for most populations in the ESU. In addition, although overall, rates would be lower than under Alternative 1, exploitation rates would generally be greater than 40 percent for many of the same management units noted under Alternative 1. The range of exploitation rates for two additional management units (White River [upper end of range only] and Stillaguamish) are anticipated to exceed 40 percent, significantly greater than the rates anticipated under Alternative 1. Seven management units could exceed 40 percent exploitation rate as compared with five management units under Alternative 1, although the lower end of the range for the Skagit summer/fall and Green-Duwamish management units would be below 40 percent under Alternative 2 (Table 4.3.6.1-1). Six management units would be expected to exceed 40 percent exploitation in southern U.S. fisheries compared with three under Alternative 1 (Table 4.3.6.1-2). However, where exploitation rates would be lower than under Alternative 1, it is reasonable to expect that the proportion of older and larger fish in the escapement in many rivers would increase slightly; i.e., decreasing selective effects. On the other hand, the shift to terminal-area fishing could increase the use of selective gear types; i.e., gillnets and hook-and-line recreational gear, and the greater number of management units anticipated to exceed 40 percent exploitation could mean an increase in selective effects compared with Alternative 1. For these reasons, there is too much uncertainty to predict the effects of implementing Alternative 2 on selective fishing effects.

#### 4.3.6.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

Implementation of Alternative 3 for the ~~2004~~ 2005–2009 management years would preclude marine net and recreational fisheries in Puget Sound, and substantially reduce exploitation rates on most chinook salmon natural populations. The size-selective effects of pre-terminal net fisheries predicted to occur under Alternative 1, would not be occur under Alternative 3. Gillnet fishery effects would be confined to those associated with in-river fisheries, and further confined to fisheries directed at other species in most rivers. The selective effects of marine recreational fisheries, which with Alternative 1 would operate under a 22-inch minimum size restriction, would also be eliminated.

Since, except for the Tulalip Bay and Stillaguamish fisheries in Alternative 2, the fisheries under Alternative 3 would be identical to those under Alternative 2, it is also anticipated that the selective fishing effects would be similar. Under Alternative 3, 6 management units out of 15 would be anticipated to exceed 40 percent exploitation rate, as compared with five under Alternative 1 and seven under Alternative 2. Five management units would be anticipated to exceed 40 percent exploitation rate in southern U.S. fisheries as compared with three under Alternative 1 and six under Alternative 2. For the reasons described under Alternative 2, there is too much uncertainty to predict the effects of implementing Alternative 3 on selective fishing effects.

#### 4.3.6.4 Alternative 4 – No Action/No Authorized Take

The closing of all fisheries that involve any take of listed Puget Sound chinook salmon would substantially lower exploitation rates on all populations relative to Alternative 1, and would eliminate any size- and age-selective effects associated with Puget Sound gillnet and recreational fisheries. The short-term consequences would include a substantial increase in escapement to all chinook salmon-producing rivers, and there would likely be some increase in proportions of ages and size represented in the spawning population. Given that observed size-selective effects of fisheries ~~have not been observed in~~ are modest, at best, for some Puget Sound chinook salmon populations, and decreases in exploitation rates would, in most cases, be from levels that are anticipated to cause low levels of size-selective effects at most, implementation of Alternative 3 is predicted to have no to low beneficial effects compared to Alternative 1.

### 4.3.7 Hatchery-Related Fishery Effects On Salmon: Straying and Overfishing

As discussed in Subsection 3.3.7 of this Environmental Impact Statement, there are two hatchery-related effects to natural-origin salmon associated with fishing. The first is straying of hatchery-origin fish that are not caught, onto the spawning grounds where they may interact with natural populations potentially leading to a decrease in overall natural population productivity. Since not all hatchery fish return to the hatchery, any increases in hatchery returns could be expected to increase the probability for higher numbers of hatchery fish spawning in the wild. The much greater escapements of hatchery coho and chum salmon could exacerbate inter-species predation, competition and genetic diversity effects in some areas. The second hatchery-related effect is the potential to overfish natural populations while pursuing harvestable hatchery-origin fish. One of the purposes of the Proposed Action is to create opportunities to harvest commingled populations, including hatchery-raised chinook, while providing an adequate level of protection to natural chinook salmon populations. In attempting to maximize harvest of hatchery fish, the commingled natural fish could be overharvested; i.e., harvested at a rate that is not sustainable based on the underlying productivity of the natural population. The potential effects on Puget Sound chinook salmon populations from overfishing are discussed in Section 4.3.1, which quantifies the impacts of the Proposed Action and alternatives in terms of exploitation rate and escapement of natural Puget Sound chinook populations. These effects will not be discussed further here.

Estimated escapement patterns for chinook salmon under the Proposed Action or alternatives for purposes of evaluating the two potential hatchery-related effects on natural-origin salmon are presented in Tables 4.3.7-1 through 4.3.7-5 by scenario. Potential contribution of hatchery-origin chinook salmon adults to the naturally-spawning population is presented in Table 4.3.7-7. Estimated escapement patterns for coho and chum are presented in Tables 4.3.7-8 and 4.3.7-9. The model runs on which these numbers are based are found in Appendix B. These are the Puget Sound salmon species with the largest hatchery production, and therefore the species with the greatest potential for hatchery-related effects. Puget Sound hatchery production of pink and sockeye salmon is relatively small by comparison. Results for chinook salmon are presented by alternative and scenario, with the discussion of comparison among alternatives focused on Scenario B, since that is the most likely to occur during implementation of the Proposed Action (see Subsection 4.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis, for background discussion.)

#### 4.3.7.1 Straying of Hatchery Chinook

Under the alternatives analyzed, hatchery escapement would vary in concert with natural escapement. Alternative 4 (No Authorized Take/Status Quo) is predicted to result in the highest escapement levels, for both hatchery- and naturally-spawning chinook, regardless of scenario. In most cases, Alternative 1 is predicted to result in the lowest overall hatchery escapement levels, and the lowest natural escapement for the Strait of Juan de Fuca, North Puget Sound, and Hood Canal populations (Table 4.3.7-1). Total natural chinook escapement is predicted to show no to low changes (-6% to +3%) under Alternatives 2 or 3 compared with Alternative 1, and low to moderate changes in total hatchery escapement, with the direction of change depending on the scenario. Compared with Alternative 1, Alternative 4 is predicted to result in substantial increases in total natural escapement of chinook salmon when abundance is similar to that in 2003 (Scenarios A or B), and moderate increases in escapement when abundance is low (Scenarios C or D). Hatchery escapements under Alternative 4 are predicted to substantially increase under all scenarios (62 to 89%) (Table 4.3.7-1).

Table 4.3.7-1. Comparisons of hatchery- and naturally-spawning chinook salmon escapement with the Proposed Action or alternatives by scenario.

| CHINOOK | Scenario A | | | | | | Scenario B | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Comparisons to the Proposed Action | | | | | | Comparisons to the Proposed Action | | | | | |
| | Natural Escapment | | | Hatchery Escapement | | | Natural Escapment | | | Hatchery Escapement | | |
| | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 |
| **Juan de Fuca** | | | | | | | | | | | | |
| Dungeness Spring | 2% | 2% | 2% | | | | 2% | 2% | 2% | | | |
| Western Strait-Hoko | 3% | 3% | 3% | | | | 3% | 3% | 3% | | | |
| Elwha | 2% | 2% | 2% | | | | 2% | 2% | 2% | | | |
| Regional Average | 2% | 2% | 2% | | | | 3% | 3% | 3% | | | |
| **North Sound** | | | | | | | | | | | | |
| Nooksack Spring | 9% | 9% | 9% | | | | 13% | 13% | 13% | | | |
| Nooksack/Samish summer-fall | | | | 237% | 237% | 0% | | | | 1% | 1% | 1% |
| Skagit | | | | | | | | | | | | |
| Spring | 8% | 8% | 8% | 8% | 8% | 8% | 9% | 9% | 9% | 9% | 9% | 9% |
| Summer/Fall | 26% | 26% | 26% | | | | 26% | 26% | 26% | | | |
| Stillaguamish | -61% | 6% | 6% | | | | -60% | 7% | 7% | | | |
| Snohomish | -9% | 8% | 9% | -12% | 8% | 19% | -6% | 10% | 10% | -9% | 20% | 20% |
| Tulalip Tribal Hatchery | | | | 99% | 7974% | 7974% | | | | 101% | 7990% | 7990% |
| Regional Average | -5% | 11% | 12% | 78% | 85% | 9% | -4% | 13% | 13% | 0% | 10% | 10% |
| **South Sound** | | | | | | | | | | | | |
| Lake Washington (Cedar River) | 1% | 1% | 1% | 18% | 18% | 18% | 0% | 0% | 0% | 19% | 19% | 19% |
| Green-Duwamish | 0% | 0% | 81% | 19% | 19% | 116% | 0% | 0% | 75% | 19% | 19% | 109% |
| Puyallup | -50% | -50% | 37% | -53% | -53% | 99% | -50% | -50% | 31% | -54% | -54% | 86% |
| Nisqually | -1% | -1% | 202% | 0% | 0% | 204% | -2% | -2% | 190% | -2% | -2% | 191% |
| White Spring | -32% | -32% | 25% | | | | -31% | -31% | 23% | | | |
| Gorst, Grovers, Minter, Chambers | | | | 31% | 31% | 42% | | | | 29% | 29% | 40% |
| & McAllister, Deschutes | | | | | | | | | | | | |
| Regional Average | -16% | -16% | 69% | 3% | 3% | 96% | -17% | -17% | 64% | 2% | 2% | 89% |
| **Hood Canal** | | | | | | | | | | | | |
| Mid-Canal | 4% | 4% | 4% | | | | 5% | 5% | 5% | | | |
| Skokomish | 1% | 1% | 105% | 1% | 1% | 100% | 0% | 0% | 92% | 0% | 0% | 88% |
| Hoodsport H, Dewato, Union, | 6% | 6% | 6% | -67% | -67% | 237% | 6% | 6% | 6% | -66% | -66% | 235% |
| & Tahuya tribs. | | | | | | | | | | | | |
| Regional Average | 2% | 2% | 54% | 26% | 26% | 77% | 2% | 2% | 48% | 26% | 26% | 77% |
| Average | -6% | 0% | 33% | 17% | 19% | 89% | -5% | 0% | 31% | -9% | -6% | 84% |

| CHINOOK | Scenario C | | | | | | Scenario D | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Comparisons to the Proposed Action | | | | | | Comparisons to the Proposed Action | | | | | |
| | Natural Escapment | | | Hatchery Escapement | | | Natural Escapment | | | Hatchery Escapement | | |
| | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 |
| **Juan de Fuca** | | | | | | | | | | | | |
| Dungeness Spring | 2% | 2% | 2% | | | | 3% | 3% | 3% | | | |
| Western Strait-Hoko | 3% | 3% | 3% | | | | 4% | 4% | 4% | | | |
| Elwha | 2% | 2% | 2% | | | | 3% | 3% | 3% | | | |
| Regional Average | 3% | 3% | 3% | | | | 3% | 3% | 3% | | | |
| **North Sound** | | | | | | | | | | | | |
| Nooksack Spring | 9% | 9% | 9% | | | | 13% | 13% | 13% | | | |
| Nooksack/Samish summer-fall | | | | 0% | 0% | 0% | | | | 121% | 121% | 1% |
| Skagit | | | | | | | | | | | | |
| Spring | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% |
| Summer/Fall | 27% | 27% | 27% | | | | 27% | 27% | 27% | | | |
| Stillaguamish | -44% | 7% | 7% | | | | -42% | 7% | 7% | | | |
| Snohomish | 9% | 9% | 9% | 20% | 20% | 20% | 9% | 9% | 9% | 20% | 20% | 20% |
| Tulalip Tribal Hatchery | | | | 9517% | 9517% | 9517% | | | | 9484% | 9484% | 9484% |
| Regional Average | 2% | 13% | 13% | 10% | 10% | 10% | 4% | 13% | 13% | 50% | 50% | 10% |
| **South Sound** | | | | | | | | | | | | |
| Lake Washington (Cedar River) | -4% | -4% | -4% | 0% | 0% | 0% | -5% | -5% | -5% | 24% | 24% | 24% |
| Green-Duwamish | 0% | 0% | 27% | 31% | 31% | 66% | 0% | 0% | 21% | 33% | 33% | 61% |
| Puyallup | -33% | -33% | 28% | -26% | -26% | 120% | -35% | -35% | 19% | -30% | -30% | 96% |
| Nisqually | -2% | -2% | 108% | -1% | -1% | 109% | -1% | -1% | 104% | 0% | 0% | 105% |
| White Spring | -1% | -1% | 27% | | | | -1% | -1% | 23% | | | |
| Gorst, Grovers, Minter, Chambers | | | | 44% | 44% | 55% | | | | 46% | 46% | 57% |
| & McAllister, Deschutes | | | | | | | | | | | | |
| Regional Average | -8% | -8% | 37% | 9% | 9% | 70% | -8% | -8% | 32% | 15% | 15% | 69% |
| **Hood Canal** | | | | | | | | | | | | |
| Mid-Canal | 5% | 5% | 5% | | | | 5% | 5% | 5% | | | |
| Skokomish | -1% | -1% | 40% | -1% | -1% | 38% | -1% | -1% | 32% | -1% | -1% | 32% |
| Hoodsport H, Dewato, Union, | 6% | 6% | 6% | -56% | -56% | 212% | 6% | 6% | 6% | -54% | -54% | 207% |
| & Tahuya tribs. | | | | | | | | | | | | |
| Regional Average | 2% | 2% | 22% | 26% | 26% | 77% | 2% | 2% | 19% | 26% | 26% | 77% |
| Average | -1% | 3% | 19% | -3% | -3% | 64% | 0% | 3% | 18% | 14% | 14% | 62% |

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, November 2004.

Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

Table 4.3.7-2. Comparisons of hatchery- and naturally-spawning chinook salmon escapement with the Proposed Action or alternatives under Scenario A.

| CHINOOK | Alternative 1 - Proposed Action | | Alternative 2 - Escapement Goal/Manag. Unit Level | | Alternative 3 - Escapement Goal/Pop Level/Terminal Only | | Alternative 4 - No Listed Take | | Comparisons to the Proposed Action: Natural Escapement | | | Comparisons to the Proposed Action: Hatchery Escapement | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hatchery | Natural | Hatchery | Natural | Hatchery | Natural | Hatchery | Natural | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 |
| **Juan de Fuca** | | | | | | | | | | | | | | |
| Dungeness Spring | -- | 352 | -- | 360 | -- | 360 | -- | 360 | 2% | 2% | 2% | | | |
| Western Strait-Hoko | -- | 785 | -- | 807 | -- | 807 | -- | 807 | 3% | 3% | 3% | | | |
| Elwha | -- | 2,125 | -- | 2,172 | -- | 2,172 | -- | 2,172 | 2% | 2% | 2% | | | |
| Regional Average | | | | | | | | | 2% | 2% | 2% | | | |
| **North Sound** | | | | | | | | | | | | | | |
| Nooksack Spring | -- | 388 | -- | 422 | -- | 422 | -- | 422 | 9% | 9% | 9% | | | |
| Nooksack/Samish summer-fall | 10,044 | -- | 33,887 | -- | 33,887 | -- | 10,083 | -- | | | | 237% | 237% | 0% |
| Skagit | | | | | | | | | | | | | | |
| Spring | 1,136 | 1,921 | 1,229 | 2,073 | 1,230 | 2,074 | 1,230 | 2,074 | 8% | 8% | 8% | 8% | 8% | 8% |
| Summer/Fall | 118 | 11,633 | 147 | 14,656 | 147 | 14,656 | 147 | 14,656 | 26% | 26% | 26% | | | |
| Stillaguamish | -- | 2,322 | -- | 903 | -- | 2,468 | -- | 2,468 | -61% | 6% | 6% | | | |
| Snohomish | 4,564 | 5,073 | 4,024 | 4,634 | 4,933 | 5,475 | 5,432 | 5,504 | -9% | 8% | 9% | -12% | 8% | 19% |
| Tulalip Tribal Hatchery | 98 | -- | 195 | -- | 7,906 | -- | 7,906 | -- | | | | 99% | 7974% | 7974% |
| Regional Average | | | | | | | | | -5% | 11% | 12% | 78% | 85% | 9% |
| **South Sound** | | | | | | | | | | | | | | |
| Lake Washington (w Cedar River index) | 4,632 | 305 | 5,448 | 307 | 5,449 | 307 | 5,449 | 307 | 1% | 1% | 1% | 18% | 18% | 18% |
| Green-Duwamish | 5,016 | 5,819 | 5,948 | 5,800 | 5,948 | 5,800 | 10,827 | 10,558 | 0% | 0% | 81% | 19% | 19% | 116% |
| Puyallup | 2,338 | 2,392 | 1,100 | 1,200 | 1,100 | 1,200 | 4,656 | 3,286 | -50% | -50% | 37% | -53% | -53% | 99% |
| Nisqually | 4,911 | 1,106 | 4,913 | 1,100 | 4,913 | 1,100 | 14,908 | 3,338 | -1% | -1% | 202% | 0% | 0% | 204% |
| White Spring | -- | 1,468 | -- | 1,000 | -- | 1,000 | -- | 1,831 | -32% | -32% | 25% | | | |
| Gorst, Grovers, Minter, Chambers & McAllister, Deschutes | 29,528 | -- | 38,545 | -- | 38,547 | -- | 41,786 | -- | | | | 31% | 31% | 42% |
| Regional Average | | | | | | | | | -16% | -16% | 69% | 3% | 3% | 96% |
| **Hood Canal** | | | | | | | | | | | | | | |
| Mid-Canal | -- | 531 | -- | 552 | -- | 552 | -- | 552 | 4% | 4% | 4% | | | |
| Skokomish | 6,104 | 1,211 | 6,174 | 1,218 | 6,175 | 1,218 | 12,214 | 2,482 | 1% | 1% | 105% | 1% | 1% | 100% |
| Hoodsport H, Dewato, Union, Tahuya trib | 5,594 | 591 | 1,851 | 625 | 1,851 | 625 | 18,833 | 625 | 6% | 6% | 6% | -67% | -67% | 237% |
| Regional Average | | | | | | | | | 2% | 2% | 54% | 26% | 26% | 77% |
| Total | 109,447 | 42,438 | | | 138,057 | 37,627 | 195,999 | 55,708 | Ave -6% | 0% | 22% | 17% | 19% | 89% |

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, March 2003 and November 2004.

Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

Table 4.3.7-3. Comparisons of hatchery- and naturally-spawning chinook salmon escapement with the Proposed Action or alternatives under Scenario B.

| CHINOOK | Alternative 1 - Proposed Action | | Alternative 2 - Escapement Goal/Manag. Unit Level | | Alternative 3 - Escapement Goal/Pop Level/Terminal Only | | Alternative 4 - No Listed Take | | Comparisons to the Proposed Action: Natural Escapement | | | Comparisons to the Proposed Action: Hatchery Escapement | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hatchery | Natural | Hatchery | Natural | Hatchery | Natural | Hatchery | Natural | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 |
| **Juan de Fuca** | | | | | | | | | | | | | | |
| Dungeness Spring | -- | 336 | -- | 344 | -- | 344 | -- | 344 | 2% | 2% | 2% | | | |
| Western Strait-Hoko | -- | 750 | -- | 772 | -- | 772 | -- | 772 | 3% | 3% | 3% | | | |
| Elwha | -- | 2,031 | -- | 2,079 | -- | 2,079 | -- | 2,079 | 2% | 2% | 2% | | | |
| Regional Average | | | | | | | | | 3% | 3% | 3% | | | |
| **North Sound** | | | | | | | | | | | | | | |
| Nooksack Spring | -- | 365 | -- | 412 | -- | 412 | -- | 412 | 13% | 13% | 13% | | | |
| Nooksack/Samish summer-fall | 9,855 | -- | 9,906 | -- | 9,906 | -- | 9,906 | -- | | | | 1% | 1% | 1% |
| Skagit | | | | | | | | | | | | | | |
| Spring | 1,088 | 1,845 | 1,188 | 2,009 | 1,189 | 2,010 | 1,189 | 2,010 | 9% | 9% | 9% | 9% | 9% | 9% |
| Summer/Fall | 110 | 11,029 | 139 | 13,935 | 139 | 13,935 | 139 | 13,935 | 26% | 26% | 26% | | | |
| Stillaguamish | -- | 2,281 | -- | 904 | -- | 2,446 | -- | 2,446 | -60% | 7% | 7% | | | |
| Snohomish | 4,342 | 4,901 | 3,947 | 4,603 | 5,203 | 5,368 | 5,203 | 5,368 | -6% | 10% | 10% | -9% | 20% | 20% |
| Tulalip Tribal Hatchery | 96 | -- | 192 | -- | 7,730 | -- | 7,730 | -- | | | | 101% | 7990% | 7990% |
| Regional Average | | | | | | | | | -4% | 13% | 13% | 0% | 10% | 10% |
| **South Sound** | | | | | | | | | | | | | | |
| Lake Washington (w Cedar River index) | 4,449 | 294 | 5,273 | 295 | 5,274 | 295 | 5,274 | 295 | 0% | 0% | 0% | 19% | 19% | 19% |
| Green-Duwamish | 5,019 | 5,816 | 5,982 | 5,800 | 5,981 | 5,800 | 10,470 | 10,153 | 0% | 0% | 75% | 19% | 19% | 109% |
| Puyallup | 2,424 | 2,419 | 1,109 | 1,200 | 1,109 | 1,200 | 4,506 | 3,160 | -50% | -50% | 31% | -54% | -54% | 86% |
| Nisqually | 5,007 | 1,126 | 4,920 | 1,100 | 4,920 | 1,100 | 14,587 | 3,261 | -2% | -2% | 190% | -2% | -2% | 191% |
| White Spring | -- | 1,459 | -- | 1,000 | -- | 1,000 | -- | 1,792 | -31% | -31% | 23% | | | |
| Gorst, Grovers, Minter, Chambers & McAllister, Deschutes | 28,954 | -- | 37,477 | -- | 37,479 | -- | 40,641 | -- | | | | 29% | 29% | 40% |
| Regional Average | | | | | | | | | -17% | -17% | 64% | 2% | 2% | 89% |
| **Hood Canal** | | | | | | | | | | | | | | |
| Mid-Canal | -- | 504 | -- | 527 | -- | 527 | -- | 527 | 5% | 5% | 5% | | | |
| Skokomish | 6,213 | 1,237 | 6,220 | 1,231 | 6,221 | 1,231 | 11,662 | 2,370 | 0% | 0% | 92% | 0% | 0% | 88% |
| Hoodsport H, Dewato, Union, Tahuya trib | 5,372 | 562 | 1,850 | 597 | 1,850 | 597 | 17,983 | 597 | 6% | 6% | 6% | -66% | -66% | 235% |
| Regional Average | | | | | | | | | 2% | 2% | 48% | 26% | 26% | 77% |
| Total | 109,447 | 42,438 | | | 138,057 | 37,627 | 195,999 | 55,708 | Aver -5% | 0% | 22% | -9% | -6% | 84% |

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, March 2003 and November 2004.

Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

Table 4.3.7-4. Comparisons of hatchery- and naturally-spawning chinook salmon escapement with the Proposed Action or alternatives under Scenario C.

| CHINOOK | Alternative 1 - Proposed Action | | Alternative 2 - Escapement Goal/Manag. Unit Level | | Alternative 3 - Escapement Goal/Pop Level/Terminal Only | | Alternative 4 - No Listed Take | | Comparisons to the Proposed Action: Natural Escapement | | | Comparisons to the Proposed Action: Hatchery Escapement | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hatchery | Natural | Hatchery | Natural | Hatchery | Natural | Hatchery | Natural | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 |
| **Juan de Fuca** | | | | | | | | | | | | | | |
| Dungeness Spring | -- | 245 | -- | 251 | -- | 251 | -- | 251 | 2% | 2% | 2% | | | |
| Western Strait-Hoko | -- | 545 | -- | 564 | -- | 564 | -- | 564 | 3% | 3% | 3% | | | |
| Elwha | -- | 1,480 | -- | 1,516 | -- | 1,516 | -- | 1,516 | 2% | 2% | 2% | | | |
| Regional Average | | | | | | | | | 3% | 3% | 3% | | | |
| **North Sound** | | | | | | | | | | | | | | |
| Nooksack Spring | -- | 278 | -- | 304 | -- | 304 | -- | 304 | 9% | 9% | 9% | | | |
| Nooksack/Samish summer-fall | 9,528 | -- | 9,571 | -- | 9,571 | -- | 9,571 | -- | | | | 0% | 0% | 0% |
| Skagit | | | | | | | | | | | | | | |
| Spring | 788 | 1,331 | 865 | 1,460 | 865 | 1,460 | 865 | 1,460 | 10% | 10% | 10% | 10% | 10% | 10% |
| Summer/Fall | 80 | 8,033 | 102 | 10,215 | 102 | 10,215 | 102 | 10,215 | 27% | 27% | 27% | | | |
| Stillaguamish | -- | 1,620 | -- | 909 | -- | 1,738 | -- | 1,738 | -44% | 7% | 7% | | | |
| Snohomish | 3,185 | 3,543 | 3,812 | 3,875 | 3,812 | 3,875 | 3,812 | 3,875 | 9% | 9% | 9% | 20% | 20% | 20% |
| Tulalip Tribal Hatchery | 58 | -- | 5,531 | -- | 5,531 | -- | 5,531 | -- | | | | 9517% | 9517% | 9517% |
| Regional Average | | | | | | | | | 2% | 13% | 13% | 10% | 10% | 10% |
| **South Sound** | | | | | | | | | | | | | | |
| Lake Washington (w Cedar River index) | 3,082 | 223 | 3,084 | 214 | 3,084 | 214 | 3,084 | 214 | -4% | -4% | -4% | 0% | 0% | 0% |
| Green-Duwamish | 4,558 | 5,801 | 5,950 | 5,800 | 5,950 | 5,800 | 7,558 | 7,367 | 0% | 0% | 27% | 31% | 31% | 66% |
| Puyallup | 1,478 | 1,798 | 1,100 | 1,200 | 1,100 | 1,200 | 3,250 | 2,293 | -33% | -33% | 28% | -26% | -26% | 120% |
| Nisqually | 4,972 | 1,119 | 4,914 | 1,100 | 4,914 | 1,100 | 10,408 | 2,330 | -2% | -2% | 108% | -1% | -1% | 109% |
| White Spring | -- | 1,011 | -- | 1,000 | -- | 1,000 | -- | 1,283 | -1% | -1% | 27% | | | |
| Gorst, Grovers, Minter, Chambers & McAllister, Deschutes | 18,808 | -- | 27,007 | -- | 27,007 | -- | 29,169 | -- | | | | 44% | 44% | 55% |
| Regional Average | | | | | | | | | -8% | -8% | 37% | 9% | 9% | 70% |
| **Hood Canal** | | | | | | | | | | | | | | |
| Mid-Canal | -- | 367 | -- | 385 | -- | 385 | -- | 385 | 5% | 5% | 5% | | | |
| Skokomish | 6,147 | 1,239 | 6,080 | 1,221 | 6,080 | 1,221 | 8,513 | 1,730 | -1% | -1% | 40% | -1% | -1% | 38% |
| Hoodsport H, Dewato, Union, Tahuya tribs | 4,209 | 410 | 1,857 | 436 | 1,857 | 436 | 13,126 | 436 | 6% | 6% | 6% | -56% | -56% | 212% |
| Regional Average | | | | | | | | | 2% | 2% | 22% | 26% | 26% | 77% |
| Total | 109,447 | 42,438 | | | 138,057 | 37,627 | 195,999 | 55,708 | Ave -1% | 3% | 22% | -3% | -3% | 64% |

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, March 2003 and November 2004.
Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

Table 4.3.7-5. Comparisons of hatchery- and naturally-spawning chinook salmon escapement with the Proposed Action or alternatives under Scenario D.

| CHINOOK | Alternative 1 - Proposed Action | | Alternative 2 - Escapement Goal/Manag. Unit Level | | Alternative 3 - Escapement Goal/Pop Level/Terminal Only | | Alternative 4 - No Listed Take | | Comparisons to the Proposed Action: Natural Escapement | | | Comparisons to the Proposed Action: Hatchery Escapement | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hatchery | Natural | Hatchery | Natural | Hatchery | Natural | Hatchery | Natural | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 |
| **Juan de Fuca** | | | | | | | | | | | | | | |
| Dungeness Spring | -- | 231 | -- | 237 | -- | 237 | -- | 237 | 3% | 3% | 3% | | | |
| Western Strait-Hoko | -- | 514 | -- | 532 | -- | 532 | -- | 532 | 4% | 4% | 4% | | | |
| Elwha | -- | 1,395 | -- | 1,431 | -- | 1,431 | -- | 1,431 | 3% | 3% | 3% | | | |
| Regional Average | | | | | | | | | 3% | 3% | 3% | | | |
| **North Sound** | | | | | | | | | | | | | | |
| Nooksack Spring | -- | 252 | -- | 285 | -- | 285 | -- | 285 | 13% | 13% | 13% | | | |
| Nooksack/Samish summer-fall | 9,370 | -- | 20,673 | -- | 20,673 | -- | 9,424 | -- | | | | 121% | 121% | 1% |
| Skagit | | | | | | | | | | | | | | |
| Spring | 749 | 1,270 | 825 | 1,395 | 825 | 1,395 | 825 | 1,395 | 10% | 10% | 10% | 10% | 10% | 10% |
| Summer/Fall | 75 | 7,551 | 96 | 9,625 | 96 | 9,625 | 96 | 9,625 | 27% | 27% | 27% | | | |
| Stillaguamish | -- | 1,584 | -- | 919 | -- | 1,702 | -- | 1,702 | -42% | 7% | 7% | | | |
| Snohomish | 3,007 | 3,399 | 3,596 | 3,720 | 3,596 | 3,720 | 3,600 | 3,720 | 9% | 9% | 9% | 20% | 20% | 20% |
| Tulalip Tribal Hatchery | 56 | -- | 5,351 | -- | 5,351 | -- | 5,351 | -- | | | | 9484% | 9484% | 9484% |
| Regional Average | | | | | | | | | 4% | 13% | 13% | 50% | 50% | 10% |
| **South Sound** | | | | | | | | | | | | | | |
| Lake Washington (w Cedar River index) | 2,933 | 214 | 3,648 | 204 | 3,648 | 204 | 3,648 | 204 | -5% | -5% | -5% | 24% | 24% | 24% |
| Green-Duwamish | 4,512 | 5,802 | 5,995 | 5,800 | 5,995 | 5,800 | 7,242 | 7,006 | 0% | 0% | 21% | 33% | 33% | 61% |
| Puyallup | 1,588 | 1,834 | 1,113 | 1,200 | 1,113 | 1,200 | 3,118 | 2,180 | -35% | -35% | 19% | -30% | -30% | 96% |
| Nisqually | 4,935 | 1,109 | 4,920 | 1,100 | 4,920 | 1,100 | 10,124 | 2,264 | -1% | -1% | 104% | 0% | 0% | 105% |
| White Spring | -- | 1,011 | -- | 1,000 | -- | 1,000 | -- | 1,246 | -1% | -1% | 23% | | | |
| Gorst, Grovers, Minter, Chambers & McAllister, Deschutes | 17,893 | -- | 26,063 | -- | 26,063 | -- | 28,157 | -- | | | | 46% | 46% | 57% |
| Regional Average | | | | | | | | | -8% | -8% | 32% | 15% | 15% | 69% |
| **Hood Canal** | | | | | | | | | | | | | | |
| Mid-Canal | -- | 344 | -- | 361 | -- | 361 | -- | 361 | 5% | 5% | 5% | | | |
| Skokomish | 6,069 | 1,225 | 6,038 | 1,215 | 6,038 | 1,215 | 7,983 | 1,622 | -1% | -1% | 32% | -1% | -1% | 32% |
| Hoodsport H, Dewato, Union, Tahuya tribs | 4,010 | 384 | 1,854 | 408 | 1,854 | 408 | 12,309 | 408 | 6% | 6% | 6% | -54% | -54% | 207% |
| Regional Average | | | | | | | | | 2% | 2% | 19% | 26% | 26% | 77% |
| Total | 109,447 | 42,438 | | | 138,057 | 37,627 | 195,999 | 55,708 | Ave 0% | 3% | 22% | 14% | 14% | 62% |

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, March 2003 and November 2004.

Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

Relatively small numbers of juvenile hatchery chinook are released each year into the watersheds where the Nooksack spring, Skagit, Stillaguamish, White, Dungeness and Elwha chinook salmon populations spawn and rear, either as indicator stocks for research (e.g., the Skagit hatchery programs), or as supplementation to aid in the recovery of the naturally-spawning chinook salmon populations. With the exception of the Elwha River, releases do not exceed one million juveniles each year. The hatchery programs in these systems all use the native chinook salmon populations as broodstock. Juvenile and adult hatchery fish from all but the Skagit programs are deemed essential for the recovery of the Puget Sound Chinook ESU, and are therefore listed. Straying of Skagit hatchery-origin spawning adults to natural spawning areas is insignificant because the numbers of adult fish produced by the low numbers of juveniles released is not substantial. For the other hatchery programs, escapement of adult fish produced through the supplementation programs that return to natural spawning areas is a primary objective of the program, and therefore generally seen as having an overall beneficial effect.

Annual hatchery releases of more than one million juvenile chinook salmon occur in the Snohomish, Lake Washington, Green-Duwamish, Puyallup, Nisqually and Skokomish watersheds. The hatchery programs located in the Snohomish and Green-Duwamish watersheds propagate chinook salmon derived from the native stock. Hatcheries in the Sammamish, Puyallup, Nisqually and Skokomish watersheds operate where native populations are no longer believed to exist. The hatchery and wild adult chinook salmon populations returning to these watersheds are indistinguishable from each other. With the exception of the Snohomish watershed, the majority of the returning adults are believed to be predominately first-generation, hatchery-origin fish, and any natural production is generally managed for composite escapements of hatchery- and wild-origin fish. Hatchery programs in these areas have been in place for 40 to 100 years. Given the stock origin of propagated fish, or the lack of native chinook salmon populations in these watersheds, continued straying of hatchery-origin spawning adults to natural spawning areas at present levels in these systems is unlikely to have a significant adverse effect on the extant natural-origin chinook salmon populations.

However, to the extent that increases in the contribution of hatchery-origin adults on the natural spawning grounds increase risks such as predation on naturally-produced salmon, or competition with naturally-produced salmon for food, and rearing and spawning areas, a reduction in the contribution of hatchery-origin adults on the natural spawning grounds would be considered a beneficial effect. Information is not currently available to determine with certainty what levels of hatchery contribution to naturally-spawning chinook populations in Puget Sound result in what levels of risk or benefit. State, tribal and federal agencies are currently engaged in on-going cooperative efforts to develop this understanding. Therefore, for the purpose of this analysis, a reduction in hatchery contribution will be considered a benefit, and the impact analysis metrics described in Subsection 4.3, Fish, will be used to describe the magnitude of change. All programs used in the analysis of the Proposed Action and alternatives would have significant hatchery contribution rates to natural spawning grounds regardless of the alternative or scenario (Table 4.3.7-9).

Under the alternative fishing regimes analyzed, the same factors that would cause natural escapements to increase (or decrease) would also result in higher (or lower) hatchery escapements. Since not all hatchery fish return to the hatchery, any increases in hatchery returns could be expected to increase the probability for higher numbers of hatchery fish spawning in the wild. Table 4.3.7-6 provides examples of stray rates for several key chinook salmon populations, where stray rate is defined as the proportion of the total hatchery-origin escapement not removed from the natural environment through trapping, or the number of hatchery-origin salmon that otherwise strayed from their point of release. The predicted contribution of hatchery fish to natural escapement is then computed by calculating the number of hatchery fish that would not return to the hatchery using the proportions in Table 4.3.7-6, and dividing that number by the natural escapement.

Table 4.3.7-6. Estimated 1996–2002 average number of hatchery-origin chinook salmon that spawn in the wild as a proportion of the hatchery-origin escapement for key Puget Sound chinook hatchery salmon populations under consideration (hatchery fish spawning in the wild/total hatchery fish returning).

| Population | Average Hatchery Stray Rate (1996-2002) |
|---|---|
| Nooksack | |
| North Fork | .35 |
| South Fork | .05 |
| Snohomish | |
| Skykomish | .32 |
| Snoqualmie | .09 |
| Green-Duwamish | .40 |

Source: Puget Sound Technical Recovery Team Abundance and Productivity Tables (2003).

Stray rates are not yet available for other systems, pending evaluation of mass-marked hatchery-origin returns in future years. When that information is available, it will be used to assess the contribution of hatchery-origin fish to natural escapement. The results of that assessment are expected to indicate that hatchery fish stray rates for South Puget Sound and Hood Canal watersheds will be similar to or exceed that of the Green River, with proportionally greater risks of potential impacts to any natural-origin chinook salmon populations. Therefore, the populations in Table 4.3.7-6 will be used as examples to indicate the relative impact of the Proposed Action or alternatives.

**Alternative 1 – Proposed Action/Status Quo**

No change from current baseline conditions would result from implementation of Alternative 1.

Modeled scenarios for Alternative 1 showed little variation and no consistent pattern of hatchery contribution rates across the three representative systems (Nooksack spring, Snohomish and Green-Duwamish) (Table 4.3.7-7). For the Nooksack spring system, the modeled stray rate is predicted to be the same across modeled scenarios. For the Snohomish system, the modeled stray rate is predicted to be lowest under Scenario D (30% reduction in abundance with maximum Canadian/Alaskan fisheries), followed by Scenario B (high abundance and maximum Canadian/Alaskan fisheries). Scenario C (30% reduction in abundance with Canadian/Alaskan fisheries similar to those in 2003), and Scenario A (high abundance and Canadian/Alaskan fisheries similar to those in 2003) are predicted to have the same and the lowest hatchery contribution rate, respectively. The Green-Duwamish River system is predicted to have the lowest stray rate under Scenario D or Scenario C, followed by Scenario B or Scenario A.

Hatchery strays are predicted to average approximately 93 percent of total natural escapement in the Nooksack spring system; 50 to 51 percent of total natural escapement in the Snohomish River system; and 52 to 58 percent of total natural spawners in the Green-Duwamish River system (Puget Sound Technical Recovery Team 2003).

Hatchery contribution rates of out-of-watershed-origin chinook salmon at these levels indicate a substantial potential risk of adverse ecological and genetic effects to the indigenous natural-origin populations through competition and genetic introgression, respectively. However, hatchery-origin fish straying within these watersheds are predominately of native-population-origin, which is expected to attenuate the potential for adverse ecological and genetic effects. In addition, Nooksack hatchery chinook salmon are considered essential to the recovery of the ESU, and are therefore listed along with the natural-origin fish. Given these circumstances, straying hatchery fish are expected to result in a low to moderate short-term risk of adverse impact to the ability of natural populations to sustain themselves. Impacts over the long-term would also be expected to be low to moderate, since Alternative 1 is the baseline condition.

Table 4.3.7-7. Hatchery contribution to natural spawning escapement by scenario and alternative for five representative Puget Sound chinook populations.

| **CHINOOK** | | Scenario A | | | | Scenario B | | | | Scenario C | | | | Scenario D | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Alt 1 | Alt 2 | Alt 3 | Alt 4 | Alt 1 | Alt 2 | Alt 3 | Alt 4 | Alt 1 | Alt 2 | Alt 3 | Alt 4 | Alt 1 | Alt 2 | Alt 3 | Alt 4 |
| Nooksack Spring | Escapement to the hatchery | 9,150 | 9,952 | 9,150 | 9,952 | 7,924 | 8,112 | 8,112 | 8,112 | 5,778 | 5,919 | 5,919 | 5,919 | 5,448 | 5,589 | 5,589 | 5,589 |
| North Fork Nooksack | strays from hatchery to grounds | 3,203 | 3,483 | 3,203 | 3,483 | 2,773 | 2,839 | 2,839 | 2,839 | 2,022 | 2,072 | 2,072 | 2,072 | 1,907 | 1,956 | 1,956 | 1,956 |
| | % of hatchery return to hatchery | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | total strays on grounds | 4,927 | 5,359 | 4,927 | 5,359 | 4,267 | 4,368 | 4,368 | 4,368 | 3,111 | 3,187 | 3,187 | 3,187 | 2,933 | 3,009 | 3,009 | 3,009 |
| South Fork Nooksack | strays from hatchery to grounds | 458 | 498 | 458 | 498 | 396 | 406 | 406 | 406 | 289 | 296 | 296 | 296 | 272 | 279 | 279 | 279 |
| | % of hatchery return to hatchery | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| | total strays on grounds | 482 | 524 | 482 | 524 | 417 | 427 | 427 | 427 | 304 | 312 | 312 | 312 | 287 | 294 | 294 | 294 |
| Snohomish | Escapement to the hatchery | 4,564 | 4,024 | 4,933 | 5,432 | 4,342 | 3,947 | 5,203 | 5,203 | 3,185 | 3,812 | 3,812 | 3,812 | 3,007 | 3,596 | 3,596 | 3,600 |
| Skykomish | strays from hatchery to grounds | 1,461 | 1,288 | 1,579 | 1,738 | 1,389 | 1,263 | 1,665 | 1,665 | 1,019 | 1,220 | 1,220 | 1,220 | 962 | 1,151 | 1,151 | 1,152 |
| | % of hatchery return to hatchery | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 |
| | total strays on grounds | 2,148 | 1,894 | 2,322 | 2,556 | 2,043 | 1,857 | 2,449 | 2,449 | 1,499 | 1,794 | 1,794 | 1,794 | 1,415 | 1,692 | 1,692 | 1,694 |
| Snoqualmie | | | | | | | | | | | | | | | | | |
| | strays from hatchery to grounds | 411 | 362 | 444 | 489 | 391 | 355 | 468 | 468 | 287 | 343 | 343 | 343 | 271 | 324 | 324 | 324 |
| | % of hatchery return to hatchery | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 |
| | total strays on grounds | 451 | 398 | 488 | 537 | 429 | 390 | 515 | 515 | 315 | 377 | 377 | 377 | 297 | 356 | 356 | 356 |
| Green-Duwamish | Escapement to the hatchery | 5,016 | 5,948 | 5,948 | 10,827 | 5,019 | 5,982 | 5,981 | 10,470 | 4,558 | 5,950 | 5,950 | 7,558 | 4,512 | 5,995 | 5,995 | 7,242 |
| | strays from hatchery to grounds | 2,007 | 2,379 | 2,379 | 4,331 | 2,007 | 2,393 | 2,393 | 4,188 | 1,823 | 2,380 | 2,380 | 3,023 | 1,805 | 2,398 | 2,398 | 2,897 |
| | % of hatchery return to hatchery | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| | total strays on grounds | 3,344 | 3,965 | 3,965 | 7,218 | 3,346 | 3,988 | 3,988 | 6,980 | 3,039 | 3,967 | 3,967 | 5,039 | 3,008 | 3,997 | 3,997 | 4,828 |

| **CHINOOK** | Hatchery Contribution to Natural Spawning | | | | Hatchery Contribution to Natural Spawning | | | | Hatchery Contribution to Natural Spawning | | | | Hatchery Contribution to Natural Spawning | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Alt 1 | Alt 2 | Alt 3 | Alt 4 | Alt 1 | Alt 2 | Alt 3 | Alt 4 | Alt 1 | Alt 2 | Alt 3 | Alt 4 | Alt 1 | Alt 2 | Alt 3 | Alt 4 |
| Nooksack Spring | 93% | 93% | 93% | 93% | 93% | 93% | 93% | 93% | 93% | 93% | 93% | 93% | 93% | 93% | 93% | 93% |
| Snohomish | 51% | 49% | 51% | 56% | 50% | 49% | 55% | 55% | 51% | 56% | 56% | 56% | 50% | 55% | 55% | 55% |
| Green-Duwamish | 57% | 68% | 68% | 68% | 58% | 69% | 69% | 69% | 52% | 68% | 68% | 68% | 52% | 69% | 69% | 69% |

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, November 2004.

**Alternative 2 – Escapement Goal Management at the Management Unit Level**

Under Alternative 2, the hatchery contribution rate is predicted to remain the same for the Nooksack spring system and increase within the Green-Duwamish River system, compared to Alternative 1. The hatchery contribution rate for the Snohomish River system is predicted to decline slightly under high abundance conditions (similar to those in 2003), and increase under low abundance conditions compared with Alternative 1. The magnitude of stray rates under Alternative 2 would be similar to those under Alternative 1.

Summary of Scenario Differences

As with Alternative 1, no consistent pattern of hatchery contribution rates was indicated across modeled scenarios among the three representative systems under Alternative 2 (Table 4.3.7-7). For the Nooksack spring system, the stray rate is predicted to be consistent across scenarios. For the Snohomish system, the modeled stray rate was lowest under Scenario A (high abundance and Canadian/Alaskan fisheries similar to those in 2003), and Scenario B (high abundance and maximum Canadian/Alaskan fisheries), followed by Scenario D (30% reduction in abundance with maximum Canadian/Alaskan fisheries), and Scenario C (30% reduction in abundance with Canadian/Alaskan fisheries similar to those in 2003). For the Green-Duwamish River system, the modeled stray rate was lowest under Scenarios A and C which had the same predicted stray rate, followed by Scenario B and Scenario D.

As with Alternative 1, there is little predicted variation in hatchery contribution rates across scenarios under Alternative 1 (Table 4.3.7-7). Hatchery strays are predicted to average approximately 93 percent of total natural escapement in the Nooksack spring system; 49 to 56 percent of total natural escapement in the Snohomish River system; and 68 to 69 percent of total natural spawners in the Green-Duwamish River system (Puget Sound Technical Recovery Team 2003).

Comparison of Alternative 2 with Alternative 1 (Proposed Action/Status Quo)

Under Alternative 2, Scenario B, the hatchery contribution rate is predicted to remain the same for the Nooksack spring system; increase by 11 percent for the Green-Duwamish River system, and decline by 1 percent for the Snohomish River system compared to Alternative 1 (Table 4.3.7-7). The magnitude of stray rates under Alternative 2 is predicted to be similar to those predicted under Alternative 1.

Under Alternative 2, Scenarios A, C, or D, the hatchery contribution rate is predicted to remain the same for the Nooksack spring system and increase for the Green-Duwamish River system by 11 to 17 percent compared to Alternative 1. The hatchery contribution rate for the Snohomish River system is predicted to decrease by 1 percent under Scenario A (same as Scenario B), and increase by 5 percent under Scenarios C or D, compared with Alternative 1 (Table 4.3.7-7). The differences in hatchery contribution rate between Alternative 2 and Alternative 1 would be greater under low abundance conditions (Scenarios C or D) than under high abundance conditions (Scenarios A or B) for the Snohomish and Green-Duwamish River systems.

As described under Alternative 1, the population origin of straying hatchery fish, and on-going hatchery reform measures implemented to reduce risks to natural-origin chinook salmon, bear upon any assessment of risk posed by straying hatchery fish to natural-origin fish populations. The hatchery contribution rates estimated under Alternative 2 could be expected to have an elevated adverse affect on the genetic diversity, and potentially on the productivity of natural-origin chinook salmon populations, relative to Alternative 1 for the Snohomish and Green-Duwamish River systems; however, again, the hatchery-origin fish straying within these watersheds are predominantly of native population-origin, which is expected to attenuate the potential for adverse ecological and genetic effects. Scenario B, the most likely to occur over the duration of the Proposed Action (the 2005~~4~~–2009 fishing seasons), is predicted to result in a no to low change in the hatchery contribution rate for the Nooksack spring and Snohomish systems, and a moderate change in the Green-Duwamish system hatchery contribution rate compared to Alternative 1. The greater potential for adverse effects would come from substantial increases in the escapements of hatchery coho and chum salmon that would occur in these areas. The much greater escapement of hatchery coho and chum salmon (Tables 4.3.7-8 and 4.3.7-9) could exacerbate inter-species predation, competition, and genetic diversity effects in some areas. Therefore, primarily as a result of straying non-chinook salmon species, moderate to substantial short- and long-term risks are predicted under Alternative 2 for hatchery fish straying at the levels described above to contribute, combined with other factors for decline, to impairment of the ability of natural populations to sustain themselves.

**Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only**

Under Alternative 1, the hatchery contribution rate is predicted to remain the same for the Nooksack spring system; increase for the Green-Duwamish River system, and have at most a low increase for the Snohomish River system compared to Alternative 1.

Summary of Scenario Differences

As with Alternative 1 or 2, modeled scenarios showed little variation in hatchery contribution rates among the three representative systems. The hatchery contribution rate is predicted to be consistent across scenarios for the Nooksack spring and Green-Duwamish River systems. For the Snohomish system, the modeled stray rate was lowest under Scenario A (high abundance and Canadian/Alaskan fisheries similar to those in 2003). Hatchery contribution rates under Scenarios B (high abundance and maximum Canadian/Alaskan fisheries), D (30% reduction in abundance with maximum Canadian/Alaskan fisheries), or C (30% reduction in abundance with Canadian/Alaskan fisheries similar to those in 2003) are predicted to be higher, but within 1 percent of each other.

Hatchery strays are predicted to average approximately 93 percent of total natural escapement in the Nooksack spring system; 51 to 56 percent of total natural escapement in the Snohomish River system; and 68 to 69 percent of the total natural spawners in the Green-Duwamish River system (Puget Sound Technical Recovery Team 2003).

Comparison of Alternative 3 with Alternative 1 (the Proposed Action/Status Quo)

Under Alternative 3, Scenario B, the hatchery contribution rate is predicted to remain the same for the Nooksack spring system, increase by 5 percent for the Green-Duwamish River system, and increase 11 percent for the Snohomish River system compared to Alternative 1 (Table 4.3.7-7). The magnitude of the hatchery contribution rates under Alternative 3 would be similar to the rates under Alternative 1 or 2.

With the exception of Scenario A for the Snohomish system, Alternative 3 Scenarios A, C, or D are predicted to result in hatchery contribution rates relative to Alternative 1 of within 1 percent of those described for Scenario B. Hatchery contribution rates under Alternative 3, Scenario A, for Snohomish chinook salmon are predicted to be the same as Alternative 1, or 5 percent lower than under Scenario B. Hatchery contribution rates are predicted to range from 55 to 56 percent under Scenarios C and D for the Snohomish River system, and 68 to 69 percent under all scenarios for the Green-Duwamish River system (Table 4.3.7-7).

As described above, the population origin of straying hatchery fish, and on-going hatchery reform measures being implemented to reduce risks to natural-origin chinook salmon, bear upon any assessment of risk posed by the straying hatchery fish to natural-origin fish populations. The hatchery contribution rates estimated under Alternative 3 could be expected to have an elevated adverse affect on the genetic diversity, and potentially on the productivity of the Green-Duwamish and Snohomish system natural-origin chinook salmon populations, relative to Alternative 1; however, again, the hatchery-origin fish straying within these watersheds are predominantly of native population-origin, which is expected to attenuate the potential for adverse ecological and genetic effects. Scenario B, the most likely to occur over the duration of the Proposed Action (the 2005~~4~~–2009 fishing seasons), is predicted to result in a no to low change in the hatchery contribution rate for the Nooksack spring and Snohomish systems, and a moderate change in the Green-Duwamish system contribution rate compared with Alternative 1. The greater potential for adverse effects would come from substantial increases in the escapements of hatchery coho and chum salmon. The much greater escapement of hatchery coho and chum salmon (Tables 4.3.7-8 and 4.3.7-9) could exacerbate inter-species predation, competition, and genetic diversity effects in some areas. Under Alternative 3, primarily as a result of straying of non-chinook species, there would be moderate to substantial short- and long-term risk that hatchery fish straying at the levels described above may contribute, combined with other factors for decline, to impairment of the ability of natural populations to sustain themselves.

**Alternative 4 – No Action/No Authorized Take**

The estimated hatchery contribution rate comparisons under Alternative 4 would be very similar to those estimated under Alternative 3.

Summary of Scenario Differences

Under Alternative 4, hatchery contribution rates are predicted to differ by 1 percent or less across scenarios for each system (Table 4.3.7-7). Hatchery strays would average approximately 93 percent of total natural escapement in the Nooksack spring system; 55 to 56 percent of total natural escapement in the Snohomish River system; and 68 to 69 percent of total natural spawners in the Green-Duwamish River system (Puget Sound Technical Recovery Team 2003).

Comparison of Alternative 4 with Alternative 1 (the Proposed Action/Status Quo)

The estimated hatchery contribution rates under Alternative 4, Scenario B, would be the same as those estimated under Alternative 3. The results of Scenarios A, C, or D are also predicted to be the same as Alternative 3, except for Scenario A for the Snohomish system (Table 4.3.7-7). The estimated contribution of hatchery-origin spawners to the Snohomish system natural escapement is predicted to increase to 56 percent, compared with 51 percent under Scenario A for Alternative 3 and Alternative 1. However, the magnitude of contribution rates is predicted to be the same as that of Alternative 3, so the level of hatchery-related effects to natural-origin chinook salmon populations associated with Alternative 4 would be unlikely to differ from effects surmised under Alternative 3. The much greater escapements of hatchery coho and chum salmon could exacerbate inter-species predation, competition, and genetic diversity effects in some areas. Under Alternative 4, particularly because of the substantial increases in non-chinook hatchery escapements, there would be moderate to substantial short- and long-term risks that hatchery fish straying at the levels described above may contribute, combined with other factors for decline, to impairment of the ability of natural populations to sustain themselves.

<u>Summary</u>

Hatchery contribution rates of chinook, coho, and chum salmon were predicted to be substantial for all alternatives. Chinook hatchery contribution rates were not predicted to change significantly with change in abundance or the magnitude of northern fisheries; varying 7 percent or less among scenarios for each alternative. The modeled differences in hatchery chinook contribution rates among alternatives were generally low, except for the Green-Duwamish River system where hatchery contribution rates are predicted to increased by as much as 17 percent under low abundance conditions when compared with Alternative 1. The much greater escapements of hatchery coho and chum salmon could exacerbate inter-species predation, competition, and genetic diversity effects in some areas. Particularly because of substantial increases in non-chinook hatchery escapements, there would likely be moderate to substantial short- and long-term risks that hatchery fish straying at the levels described above may contribute, combined with other factors for decline, to impairment of the ability of natural populations to sustain themselves under Alternatives 2, 3, or 4. Under Alternative 1, straying hatchery fish are expected to result in a low to moderate short-term risk of adverse impact to the ability of natural populations to sustain themselves. Impacts over the long-term are also expected to be low to moderate, since Alternative 1 is the baseline condition.

#### 4.3.7.2 Straying of Coho and Chum Salmon

Both total hatchery and natural escapement for coho and chum salmon would show substantial increases (39% to 236%) in escapement under Alternatives 2, 3, or 4 compared with Alternative 1. For each alternative, the change in hatchery escapement is predicted to be 2 to 2.5 times the change in natural escapement (Tables 4.3.7-8 and 4.3.7-9). As with chinook salmon, changes in hatchery and natural escapements would vary by region and management unit. Stray rate estimates are not available for the coho and chum salmon management units in Tables 4.3.7-8 and 4.3.7-9.

Table 4.3.7-8. Comparisons of hatchery- and natural-spawning coho salmon escapement with the proposed action and alternatives. Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

| COHO | Alternative 1 - Proposed Action | | Alternative 2 - Escapement Goal/Manag. Unit Level | | Alternative 3 - Escapement Goal/Pop Level/Terminal | | Alternative 4 - No Listed Take | | Comparisons to the Proposed Action | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Natural Escapment | | | Hatchery Escapement | | |
| | Hatchery | Natural | Hatchery | Natural | Hatchery | Natural | Hatchery | Natural | | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 |
| **Juan de Fuca** | | | | | | | | | | | | | | | |
| Juan de Fuca | 9,513 | 17,320 | 17,622 | 18,819 | 17,622 | 18,819 | 21,732 | 18,819 | | 9% | 9% | 9% | 1 | 85% | 128% |
| Regional Average | | | | | | | | | | 9% | 9% | 9% | 85% | 85% | 128% |
| **North Sound** | | | | | | | | | | | | | | | |
| Nooksack/Samish | 27,508 | 8,182 | 56,057 | 14,272 | 56,057 | 14,272 | 56,057 | 15,305 | | 74% | 74% | 87% | 1 | 104% | 104% |
| Skagit | 5,840 | 73,624 | 9,241 | 109,887 | 9,241 | 109,887 | 9,253 | 110,022 | | 49% | 49% | 49% | 1 | 58% | 58% |
| Stillaguamish | 1,173 | 24,017 | 1,239 | 28,689 | 1,317 | 34,840 | 1,317 | 34,840 | | 19% | 45% | 45% | 0 | 12% | 12% |
| Snohomish | 13,494 | 136,873 | 17,854 | 165,820 | 30,938 | 187,066 | 30,938 | 187,066 | | 21% | 37% | 37% | 0 | 129% | 129% |
| Regional Average | | | | | | | | | | 41% | 51% | 55% | 50% | 76% | 76% |
| **South Sound** | | | | | | | | | | | | | | | |
| South Sound | 119,369 | 47,086 | 233,962 | 69,945 | 233,962 | 69,945 | 293,781 | 97,804 | | 49% | 49% | 108% | 1 | 96% | 146% |
| | | | | | | | | | | 49% | 49% | 108% | 96% | 96% | 146% |
| **Hood Canal** | | | | | | | | | | | | | | | |
| Hood Canal | 11,379 | 19,012 | 37,046 | 28,533 | 37,046 | 28,533 | 41,214 | 30,345 | | 50% | 50% | 60% | 2 | 226% | 262% |
| Regional Average | | | | | | | | | | 44% | 44% | 64% | 63% | 63% | 162% |
| Total | 62,859 | 197,456 | | | 230,334 | 309,828 | 306,719 | 334,498 | Aver | 39% | 45% | 56% | 87% | 101% | 120% |

Table 4.3.7-9. Comparisons of hatchery- and natural-spawning chum salmon escapement with the proposed action and alternatives. Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

| CHUM | Alternative 1 - Proposed Action | | Alternative 2 - Escapement Goal/Manag. Unit Level | | Goal/Pop Level/Terminal Only | | Alternative 4 - No Listed Take | | Comparisons to the Proposed Action | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Natural Escapment | | | Hatchery Escapement | | |
| | Hatchery | Natural | Hatchery | Natural | Hatchery | Natural | Hatchery | Natural | | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 | Alt2/Alt1 | Alt3/Alt1 | Alt4/Alt1 |
| **Juan de Fuca** | | | | | | | | | | | | | | | |
| Juan de Fuca | -- | 2,585 | -- | 2,722 | -- | 2,722 | -- | 2,722 | | 5% | 5% | 5% | | | |
| Regional Average | | | | | | | | | | 5% | 5% | 5% | | | |
| **North Sound** | | | | | | | | | | | | | | | |
| Nooksack/Samish | 7,936 | 35,610 | 17,713 | 79,482 | 17,713 | 79,482 | 17,717 | 79,501 | | 123% | 123% | 123% | 123% | 123% | 123% |
| Skagit | 1,834 | 42,237 | 2,000 | 46,071 | 2,000 | 46,071 | 2,000 | 46,071 | | 9% | 9% | 9% | 9% | 9% | 9% |
| Stillaguamish | 700 | 14,400 | 1,631 | 34,194 | 1,668 | 34,964 | 1,668 | 34,964 | | 137% | 143% | 143% | 133% | 138% | 138% |
| Snohomish | 7,200 | 17,600 | 43,262 | 35,583 | 43,262 | 35,583 | 43,262 | 35,583 | | 102% | 102% | 102% | 501% | 501% | 501% |
| Regional Average | | | | | | | | | | 93% | 94% | 94% | 192% | 193% | 193% |
| **South Sound** | | | | | | | | | | | | | | | |
| South Sound | 17,540 | 150,923 | 46,459 | 399,761 | 46,459 | 399,761 | 51,310 | 441,499 | | 165% | 165% | 193% | 165% | 165% | 193% |
| Regional Average | | | | | | | | | | 165% | 165% | 193% | 165% | 165% | 193% |
| **Hood Canal** | | | | | | | | | | | | | | | |
| Hood Canal | 37,637 | 50,382 | 145,084 | 95,473 | 145,084 | 95,473 | 207,023 | 99,621 | | 89% | 89% | 98% | 285% | 285% | 450% |
| Regional Average | | | | | | | | | | 89% | 89% | 98% | 285% | 285% | 450% |
| Total | 72,846 | 313,736 | | | 256,149 | 693,285 | 322,981 | 739,961 | Aver | 90% | 91% | 96% | 203% | 204% | 236% |

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, March 2003 and November 2004.

### 4.3.8 Indirect and Cumulative Effects

#### 4.3.8.1 Indirect Effects

Indirect effects on fish species are those that would be further removed from the direct effects. In the case of listed and unlisted salmonid species affected by the Proposed Action, the primary direct effect would be changes in spawning escapement brought about by changes in catch, and the primary indirect effect would be resulting changes in abundance of the progeny of these spawning populations. Because the action considered in this Environmental Impact Statement applies to a~~ six~~ five-year resource management plan, changes in abundance would be limited to the progeny of spawners returning from ~~2004~~ 2005 to 2010; i.e., progeny returning in~~ 2006~~ 2007–2015. The extent to which increased abundance of the progeny of these spawners may affect spawning abundance in subsequent years depends on freshwater and marine habitat conditions that influence survival, and on the fishing regimes that will be in place after 2010. Of these, marine conditions are thought to play the dominant short-term role.

In the case of chinook salmon, changes in spawning escapement would, theoretically, be most evident in the abundance of progeny returning as Age-3 and Age-4 spawners, though there would also be changes in abundance for Age-2 (precocious) spawners, and the relatively small proportion of chinook populations returning as Age-5 and Age-6 spawners. Similarly, for other species, changes in spawning escapement would apply to subsequent brood years according to the species age-at-maturity profiles. As noted in Subsection 4.3.1, these effects could be beneficial or negative, depending on the magnitude of change and the productivity characteristics of the particular watershed from which a population originates. An indirect effect that would likely result from fishery closures under Alternative 2 is the expected reduction in the amount of lost fishing gear in marine areas closed to fishing and, conversely, an increase in lost fishing gear in those terminal fisheries where fishing may increase. Changes in the number of lost or derelict nets affect the amount of unintended mortality on salmonids and other species that become entangled in lost nets and, to a lesser extent, lost sport fishing tackle. This issue is discussed in Subsection 3.3.5 (~~, ~~Fish Habitat Affected by Salmon Fishing): Affected Environment and Subsections 4.8.1 (Marine Birds) and 4.8.3 (Marine Invertebrates): Environmental Consequences.

A potential advantage to Alternative 1, which makes use of exploitation rate management strategies for many populations, is that, properly applied, exploitation rate management strategies are more robust about uncertainties in key parameters like survival and management error (Walters and Parma 1996) than fixed escapement goal strategies like those in Alternatives 2 and 3. ~~Given the imprecision of abundance forecasts, t~~This can be an important advantage, especially when combined with a strategy to use conservative parameters in forecasting (Fieberg ~~in press~~ 2004). Exploitation management strategies can also result in less variable harvests from year to year (Hilborn and Walters 1992; Walters and Parma 1996), an important factor for fishermen that rely on fishing for their family income. Also, in practical terms, true fixed escapement goal harvest management is difficult to impossible to implement. When direct and incidental harvest is regulated under several jurisdictions (national and international), it is not possible to actually reduce harvest exploitation rates to zero when threshold escapement levels cannot be achieved, although they can be significantly reduced.

Fieberg (2004) considered the uncertainty associated with estimating population productivity and with managing fisheries (i.e., management and forecast error) to achieve escapement thresholds or target exploitation rates under several harvest management strategies. His analysis showed that, given the uncertainty associated with estimating population productivity, and with implementing harvest management, imposing exploitation rate harvest objectives could result in more stable harvest than a fixed escapement goal strategy, without increasing the risk of population extinction.

Fieberg examined the probability of extinction (as measured over 50 years and compared with the probability under a minimal harvest condition) using several risk criteria, and found that it was consistently greater using a fixed escapement goal management strategy than under exploitation rate strategies regardless of the risk criterion used. The probability of extinction was significantly increased under the fixed escapement goal strategy when survival rates were biased (survival was actually lower than assumed). The exploitation rate strategies showed low or no increased probability of extinction under biased survival compared with unbiased estimates of survival. The reason is that the optimal parameters; i.e., harvest objectives (critical escapement threshold and exploitation rate designed to maximize harvest), under the fixed escapement goal strategy are close to the risk criteria as compared to those of the exploitation rate strategies. Therefore, even slight errors in the determination of the optimal parameters would result in probabilities of extinction greater than the risk criteria. The probability of extinction was greatly reduced when management buffers (i.e. setting escapement thresholds high to accommodate forecast and management error, or setting exploitation targets lower) were used such that the probability of extinction was low across all management strategies under unbiased survival rates. When survival rates were biased as may be the case in actual harvest management, the probability of extinction was once again much higher for the fixed escapement goal strategy compared with the exploitation rate strategies, although significantly lower than without the use of management buffers.

Expected harvest was generally equivalent for different management strategies[xv], except when forecast error was very high, because in this circumstance a high threshold is required to maintain low extinction risk. Exploitation rate strategies generally require 'trading' lower exploitation rate objectives for lower thresholds, thereby constraining harvest in high abundance years in exchange for allowing more harvest in low abundance years, again while maintaining low extinction risk. In general, increasing threshold parameters will result in more variable yields over time, but may also increase the average long-term harvest (relative to the same strategy employed with a lower threshold and lower exploitation rate parameter). Thus, there are tradeoffs in terms of maximizing catch versus reducing variability in catch that can be controlled to some extent by adjusting threshold parameters or adjusting exploitation rate parameters.

These tradeoffs are also inherent in the various harvest strategies. In a sense, the exploitation rate strategy, similar to that proposed in Alternative 1, trades lower escapement thresholds for lower exploitation rates when forecasted abundances are above these thresholds. As such, the exploitation rate strategy would harvest more fish at low forecasted abundances than the fixed escapement goal strategy of Alternatives 2 or 3, but fewer fish at high forecasted abundances.

The analysis clearly identifies the elevated extinction risk associated with failing to incorporate uncertainty in estimating populations parameters (e.g., productivity) when determining the optimal harvest threshold. It also points out the risk of underestimating the true critical escapement threshold for a population, whether the harvest strategy involves escapement thresholds or exploitation rates.

Regardless of the strategy, the methods used to optimize the strategies are likely to be as important as the strategy itself. Fieberg's analysis demonstrated the advantage of using management buffers. The results suggest that using buffers may provide a high degree of insurance against over-harvesting without a big loss in terms of realized harvest. Harvest benefits were very slightly decreased, while reducing the risk of extinction. The Proposed Action incorporates such buffers by setting the low abundance threshold substantially above the critical level, and by incorporating management error in the simulation model used to determine RERs.

[xv] Because Fieberg concluded that absolute zero harvest below an escapement threshold was impractical, all the management strategies he evaluated had some level of harvest allowed below the escapement threshold, although it was minimal under some strategies. Therefore, his escapement goal strategies were not exactly the same as those of Alternatives 2 and 3 in which no harvest occurs at abundances below the escapement threshold.

Another advantage of Alternative 1 compared to Alternative 2 (or 3) is that, at higher abundances, Alternative 1 would be expected to return even more chinook spawners than under fixed escapement goal management as exemplified by Alternative 2. The high abundance scenarios (Scenarios A and B) support this for some systems (e.g., the Stillaguamish River, Snohomish River, Puyallup River). As population abundance increases above current levels, this would be expected to be the case for more chinook river systems. Conversely, under significantly lower abundance, Alternative 1 would be expected to return fewer spawners than under fixed escapement goals for Alternatives 2 or 3, although the current modeling of Scenarios B and D do not reflect this even at a 30 percent reduction in abundance from current levels.

**Indirect Effects of Alternative 2 (Escapement Goal Management at the Management Unit Level or Alternative 3 (Escapement Goal Management at the Population Level) on Listed Chinook and Chum Salmon Populations**

The direct effects of predicted spawning escapement for Alternative 2, Scenario B (considered the most likely abundance scenario) compared to Alternative 1, Scenario B were predicted to be of a low to moderate beneficial nature for 11 of the 22 populations in the listed Puget Sound Chinook Evolutionarily Significant Unit. (Modeled results of spawning escapement showed an increase from 2% to 26%.) Given favorable river and marine survival conditions, and fishing regimes resembling those in place prior to the action, these increases could result in low to moderate increases in spawning returns. However, similar decreases in exploitation rates for some of these same chinook salmon populations observed in recent years have not been accompanied by increases in natural-origin spawners. This suggests that habitat factors may be the primary constraint on natural production (NMFS 2004 [4(d) determination]), and therefore increases in parental escapement would not result in increased abundance in subsequent generations.

Modeled results of changes in chinook salmon spawning escapement for the remaining populations varied. Most notably, escapement was predicted to decline by 60 percent for the North Fork and South Fork Stillaguamish chinook salmon populations. Escapement of the Puyallup River fall and White River Spring chinook salmon populations both were predicted to decline substantially (50% and 31%, respectively). Changes of these magnitudes would be much more likely to have measurable effects on abundance and escapement of the subsequent brood years. As noted in Subsection 4.3.1.2, however, escapements of the North Fork Stillaguamish, Puyallup and White River chinook salmon populations under Alternative 2 were predicted to meet current-condition escapement goals. Therefore, it is not necessarily accurate to assume that the indirect effect of Alternative 2 would be substantially negative.

The indirect effects of Alternative 3 would be essentially the same as Alternative 2, with the exception that the Stillaguamish chinook salmon management unit, where escapement was predicted to decline 60 percent relative to Alternative 1 under Alternative 2, would increase by approximately 7 percent relative to Alternative 1, under Alternative 3.

Fixed escapement goal management strategies, as in Alternative 2 or 3, are less robust to uncertainties in key parameters like survival and management error~~. Given the imprecision of abundance forecasts, this could be an important advantage~~ (Fieberg 2004 ~~*in press*~~).

**Indirect Effects of Alternative 4 (No Fishing) on Listed Chinook and Chum Salmon Populations**

The direct effects of Alternative 4 (No Fishing) would be an increase in escapement for all Puget Sound chinook salmon populations relative to Alternative 1 (the Proposed Action). In North Puget Sound and the Strait of Juan de Fuca, increases in chinook salmon escapement would be very similar to the increases under Alternative 2 or 3. In South Puget Sound and Hood Canal, increases in chinook salmon escapement are predicted to range from 5 percent for the Mid-Hood Canal chinook salmon population, to 190 percent for the Nisqually chinook salmon population. In addition to the substantial increase in spawning escapement for the Nisqually chinook salmon population, increases of 75 percent for the Green River population, 31 percent for the Puyallup River population, and 92 percent for the Skokomish River population were predicted by the model. Increased escapements of this magnitude could result in moderate to substantial increases in the spawning escapement of subsequent brood years. However, there is also a possibility that escapements substantially in excess of current-condition escapement goals would result in decreased survival owing to overcrowding of available freshwater spawning and rearing habitat, and increased competition for food. However, much less severe decreases in exploitation rates for some of these same populations observed in recent years have not been accompanied by increases in natural-origin chinook salmon spawners. This suggests that habitat factors may be the primary constraint on natural production (NMFS 2004 [4(d) determination]), and therefore increases in parental escapement would not result in increased abundance in subsequent generations.

**Indirect Effects of Alternative 2 or 3 on Other Salmon Species**

As noted in Subsections 4.3.2.2 and 4.3.2.3, Alternative 2 or 3 would substantially increase escapement of coho, pink, and fall chum salmon relative to Alternative 1. Modeling results predicted that overall escapement of naturally-spawning fish would increase from 44 percent to 136 percent depending on the species and the harvest management alternative selected. While this could have the effect of substantially increasing escapement of subsequent brood years, modeled escapements in many management units substantially exceed current-condition escapement goals, and could result in decreased productivity. For many coho salmon management units, exploitation rate objectives are based on stock recruit functions which would predict that large increases in escapement would not result in substantial increases in progeny (personal communication via e-mail from William Beattie to The William Douglas Company, February 17, 2004). There would be similarly large increases in the escapement of hatchery-origin spawners, with the likely result that there would be increased straying of hatchery fish to the spawning grounds. The indirect effects on sockeye populations would be low or none. Indirect effects on steelhead populations would be low or none owing to the very small changes in catch on this species under either Alternative 2 or 3.

#### 4.3.8.2 Cumulative Effects of the Proposed Action or Alternatives on Fish Species

NEPA defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR1508.7). For the purpose of this discussion, the terms "effects" and "impacts" will be considered synonymously with "consequences," and consequences may be negative or beneficial. This subsection presents an analysis of the cumulative effects (negative or beneficial) of the Proposed Action on fish resources in the context of other local, state, tribal, and federal management activities in the Puget Sound region.

The geographic scope of the cumulative effects analysis area includes the entire Puget Sound region. The analysis area covers both inland and marine environments that are managed under laws, policies, regulations, and plans having a direct or indirect impact on fish. The substantive scope of the cumulative effects analysis is predicated on a review of laws, policies, regulations, and plans that specifically pertain to fish-related management activities or that have an indirect negative or beneficial effect on fish resources. These laws, policies, regulations, and plans are described in Section 1 and Appendix F. Due to the geographic scope of the analysis area, it is not feasible to analyze all habitat-specific activities that are occurring, have occurred in the past, or that will occur in the future in a quantitative manner. By reviewing applicable laws, policies, regulations, and plans, the analysis captures the objectives of management activities that are occurring or are planned to occur that may interface with fish resources within the Puget Sound region. It is assumed that no management activity is occurring or would occur outside of an implemented law, policy, regulation, or sanctioned plan at the federal, tribal, state, or local level. Although the analysis is necessarily qualitative, it provides a thorough review of other activities within the region that, when combined with the Proposed Action, could have a negative or beneficial affect on fish resources. Table 4.3.8.2-1 summarizes the potential cumulative effects of implementing the Proposed Action or alternatives with the effects of these existing plans, policies, programs, and laws.

The Proposed Action is implementation of the Puget Sound Chinook Harvest Resource Management Plan (RMP), jointly prepared by the Washington Department of Fish and Wildlife (WDFW) and the Puget Sound Treaty Tribes (co-managers). Factors common to the relationship between the RMP and the various existing plans, policies and programs include: 1) the Resource Management Plan would provide protection to Puget Sound chinook salmon by conserving the productivity, abundance, and diversity of populations within the Puget Sound Chinook Evolutionarily Significant Unit (ESU), while managing harvest of strong salmon stocks; and 2) conserving productivity requires biological integrity in the freshwater systems in which salmon spawn and rear. As shown in Table 4.3.8.2-1, the RMP would be consistent with the intent and policies of each of the federal, tribal, state, and local plans, programs, and laws reviewed for the cumulative effects analysis, and is predicted to enhance the benefits of these other measures as they relate to the conservation and/or enhancement of fish and wildlife habitat and fish populations.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004.

| Federal/Tribal/State/Local | | |
|---|---|---|
| **Plans, Policies, and Programs** (in chronological order of earliest to most recent) | **Description and Intent** | **Cumulative Effect when Combined with the Proposed Action** |
| **Fish and Wildlife Coordination Act, 1956, as amended in 1964 (FWCA).** | The FWCA recognizes "the vital contribution of our wildlife resources to the Nation, the increasing public interest and significance thereof due to expansion of our national economy and other factors, and to provide that wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs through the effectual and harmonious planning, development, maintenance, and coordination of wildlife conservation and rehabilitation." | The Resource Management Plan would allow the harvest of salmon in coordination with ongoing conservation and rehabilitation efforts for chinook salmon. With an estimated value of $35 million ($16.2 million commercial plus $18.8 million recreational), the Puget Sound fishing industries are important to the Nation's economy. The Proposed Action would be consistent with the FWCA by recognizing the vital contribution of Puget Sound chinook salmon to the Nation and our national economy. It is predicted that implementation of the Resource Management Plan, in combination with the FWCA, would strive to balance considerations of the national economy, while also providing for fish conservation. |
| **Washington State Shoreline Management Act of 1971 (SMA).** | The SMA was adopted in Washington in 1972 with the goal of "prevent[ing] the inherent harm in an uncoordinated and piecemeal development of the state's shorelines." The provisions of this law are designed to guide the development of the shoreline lands in a manner that will promote and enhance the public interest. The law expresses the public concern for protection against adverse effects to public health, the land and its vegetation and wildlife, and the aquatic life of the waters. | Rearing habitat within shoreline areas of Washington State is essential to conserving the productivity of Puget Sound chinook salmon. Consequently, the Proposed Action would be consistent with the SMA by ensuring that harvest works in concert with habitat protection efforts under the SMA. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the SMA, would protect fish from adverse effects associated with uncoordinated and piecemeal development of the state's shorelines. |
| **The National Marine Sanctuaries Act.** Also known as Title III of the Marine Protection, Research, and Sanctuaries Act of 1972 **(MPRSA)**. | The MPRSA authorizes the Secretary of Commerce to designate and manage areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or a esthetic qualities as National Marine Sanctuaries. One of the purposes and policies of the MPRSA is "to maintain the natural biological communities in the national marine sanctuaries, and to protect, and, where appropriate, restore and enhance natural habitats, populations, and ecological processes." | Protecting the marine environment where chinook salmon mature is important to conserving the productivity of Puget Sound chinook salmon. Consequently, the Proposed Action would be consistent with the MPRSA by maintaining chinook salmon populations of the natural biological communities in the marine environment. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the MPRSA, would strive to restore and enhance natural habitats, populations, and ecological processes of fish. |

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

| Federal/Tribal/State/Local | | |
|---|---|---|
| **Plans, Policies, and Programs** (in chronological order of earliest to most recent) | **Description and Intent** | **Cumulative Effect when Combined with the Proposed Action** |
| **Coastal Zone Management Act of 1972 (CZMA), as amended through The Coastal Zone Protection Act of 1996.** | The CZMA declares the national policy is "to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations by "the protection of natural resources, including wetlands, floodplains, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife and their habitat, within the coastal zone." | Chinook salmon are one of the Nation's resources within the CZMA's coastal zone. The Proposed Action would be consistent with the CZMA by encouraging preservation and protection of Puget Sound chinook salmon and their habitat within the coastal zone for existing and succeeding generations, and by ensuring that harvest is consistent with the production and capacity of the habitat. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the CZMA, would preserve, protect, restore or enhance the fish resources of the Nation's coastal zone. |
| **Marine Mammal Protection Act of 1972, as amended through 1996 (MMPA).** | The MMPA establishes a Federal responsibility to conserve marine mammals, with management vested in the Department of Commerce for cetaceans and pinnipeds other than walrus. The MMPA states that the "Secretary must undertake a program of research and development for improving fishing methods and gear to reduce to the maximum extent practical the incidental taking of marine mammals in commercial fishing." To meet this requirement, the "Secretary must issue regulations to reduce to the lowest practical level the taking of marine mammals incidental to commercial fishing operations." Secretary of Commerce has issued regulation that prohibits deterrent devices that might seriously injure or kill a marine mammal and for fishermen to report unintentional marine mammal mortality. | The Proposed Action would be consistent with the MMPA to conserve marine mammals because the fisheries would be in compliance with Department of Commerce regulations to reduce to the lowest practical level the take of marine mammals incidental to commercial fishing operations. Although not specifically addressed in the Resource Management Plan, Department of Commerce regulations require Puget Sound fishermen to use non-lethal deterrent devices and to report unintentional marine mammal mortality. As chinook salmon are prey of marine mammals, implementation of the Resource Management Plan, in combination with the MMPA, is predicted to potentially reduce the amount of available prey for marine mammals over what would have been available had the fisheries not occurred. It is also true that the fisheries reduce the number of salmon in the short term because they are removing fish, some of which would otherwise spawn. Over the long term, however, it is expected that the RMP will aid in the recovery of the populations by ensuring that enough fish escape to produce more in subsequent generations as habitat improves. |

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

| Federal/Tribal/State/Local | | |
|---|---|---|
| **Plans, Policies, and Programs** (in chronological order of earliest to most recent) | **Description and Intent** | **Cumulative Effect when Combined with the Proposed Action** |
| **The Endangered Species Act of 1973, as amended through December, 1996 (ESA).** | The purpose of the ESA is "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species…" On July 10, 2000, NMFS issued a rule under section 4(d) of the ESA (referred hereafter as the 4(d) Rule). The 4(d) Rule provided limits on the application of the take prohibitions; i.e., take prohibitions would not apply to the plans and activities set out in the rule if those plans and activities adequately address criteria of the rule, including that implementation and enforcement of the resource management plan will not appreciably reduce the likelihood of survival and recovery of affected threatened ESUs. | The Puget Sound Chinook Salmon ESU is listed as threatened under the ESA. The Proposed Action to implement the Puget Sound Chinook Salmon Resource Management Plan includes a condition that the Secretary of Commerce will determine whether the Resource Management Plan adequately addresses the criteria outlined in Limit 6 of the ESA 4(d) Rule. Consequently, the Proposed Action would be consistent with the ESA by meeting these criteria designed to foster goals and objectives of the ESA, including to avoid appreciably reducing the likelihood of survival and recovery of Puget Sound chinook salmon ESU. The ESA would not only have a beneficial impact to listed Puget Sound chinook salmon, but species listed under the ESA also include predators of chinook salmon such as bull trout and bald eagle. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the ESA, would potentially have both unquantifiable beneficial and adverse impacts on fish resources. |
| **United States of America, Plaintiff, Quinault Tribe of Indians on its own behalf and on behalf of the Queets Band of Indians, et al., Intervenor-Plaintiffs, v. State of Washington, Defendant, Thor C. Tollefson, Director, Washington State Department of Fisheries, et al., Intervenor-Defendants, Case number C70-9213, February 12, 1974 (Boldt Decision).** | The Boldt Decision reaffirmed the rights of Washington Indian tribes to fish in accustomed places, and allocated 50 percent of the annual catch to treaty tribes. Judge Boldt held that the government's promise to secure the fisheries for the tribes was central to the treaty-making process, and that the tribes had an original right to the fish, which they extended to white settlers. Judge Boldt ordered the state to take action to limit fishing by non-Indians. The court decision recognized that "assuring proper spawning escapement is the basic element of conservation involved in restricting the harvest of salmon and Steelhead." The decision further defined adequate production escapement as "… that level of escapement from each fishery which will produce viable offspring in numbers to fully utilize all natural spawning grounds and propagation facilities reasonable and necessary for conservation of the resource…" | The objectives and principles of the Resource Management Plan jointly developed by the co-managers include compliance with the requirements of the Boldt Decision. The Boldt Decision would not have an appreciable effect on the total harvest, but addresses which party and where the harvest can occur. The Boldt Decision encourages the conservation of the species. The Resource Management Plan would conserve the productivity, abundance, and diversity of chinook salmon populations within the ESU. Therefore, it is predicted that implementation of the Resource Management Plan, in combination with the Boldt Decision, would have a beneficial impact on fish resources. |

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

| Federal/Tribal/State/Local | | |
|---|---|---|
| **Plans, Policies, and Programs** (in chronological order of earliest to most recent) | **Description and Intent** | **Cumulative Effect when Combined with the Proposed Action** |
| **State of Washington, Chapter 76.09 of the Revised Code of Washington (RCW), Forest Practices Act (FPA), 1974.** | The FPA defines a plan to protect public resources while assuring that Washington continues to be a productive timber-growing area. The FPA regulates activities related to growing, harvesting or processing timber on all local government, state and private forest lands. The Washington Forest Practices Board was established in 1975 by the Legislature under the State Forest Practices Act. By law, the board is charged with establishing rules to protect the state's natural resources while maintaining a viable timber industry. Those rules, as embodied in the Washington Administrative Code (WAC), specifically consider the effects of various forest practices on fish, wildlife and water quality, as well as on capital improvements of the state or of its political subdivisions. | The Proposed Action would be consistent with the intent of the FPA to protect the natural resources of Washington State. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the FPA, would have a net beneficial impact on fish resources. |
| **The Clean Water Act, 1977, (CWA). A 1977 amendment to the Federal Water Pollution Control Act (FWPCA) was titled "The Clean Water Act."** | The objective of the CWA is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. As stated in the CWA, maintaining or restoring water quality "provides for the protection and propagation of fish, shellfish, and wildlife…" | The fisheries that would be allowed by the Resource Management Plan are predicted to have minimal to negligible effect on the Nation's water quality. Primarily because the CWA would maintain water quality that provides for the protection and propagation of fish, it is predicted that implementation of the Resource Management Plan, in combination with the CWA, would have a net beneficial impact on fish resources. |
| **The Treaty between the Government of Canada and the Government of the United States of America concerning Pacific Salmon, 1985, including 1999 revised annexes (Pacific Salmon Treaty).** | The Pacific Salmon Treaty calls on the U.S. and Canada (Parties) to conduct its fisheries as to "prevent overfishing and provide for optimum production." The Pacific Salmon Treaty defines "overfishing" as "fishing patterns which result in escapements significantly less than those required to produce maximum sustainable yields [MSY]." Annex IV, Chapter 3, Chinook Salmon of the Pacific Salmon Treaty further states that the Parties shall establish a chinook management program that "sustains healthy stocks and rebuilds stocks that have yet to achieve MSY or other biologically-based escapement objectives." Salmon subject to the Pacific Salmon Treaty includes Pacific salmon stocks which originate in the waters of one Party and subject to interception by the other Party. | Puget Sound chinook salmon are intercepted in Canadian fisheries under the authority of the Pacific Salmon Treaty. The Resource Management Plan accounts for all sources of fishery-related chinook salmon mortality, including mortality related to Canadian fisheries. Although the Resource Management Plan would allow exploitation rates that would result in escapements less than those required to produce maximum sustainable yields in some years, the Resource Management Plan would, overall, sustain healthy populations and rebuild stocks toward maximum sustainable yield. Consequently, the Proposed Action would be consistent with the Pacific Salmon Treaty. Accordingly, it is predicted that the implementation of the Resource Management Plan, in combination with the Pacific Salmon Treaty, would have a net beneficial impact on fish resources. |

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

| **Federal/Tribal/State/Local** | | |
|---|---|---|
| **Plans, Policies, and Programs** (in chronological order of earliest to most recent) | **Description and Intent** | **Cumulative Effect when Combined with the Proposed Action** |
| **State of Washington, Chapter 36.70A RCW Growth Management – Planning by Selected Counties and Cities**. Commonly referred to as the Growth Management Act **(GMA)**. Adopted by the state in 1990. | The GMA guides the development and adoption of comprehensive land use plans and development regulations of counties and cities within the state of Washington. The goals of the GMA include: "[m]aintain and enhance natural resource-based industries, including productive timber, agricultural, and fisheries industries" and "[p]rotect the environment and enhance the state's high quality of life, including air and water quality, and the availability of water." | The fisheries that would be allowed by the Resource Management Plan are predicted to have minimal to negligible effect on Washington State water quality. It is predicted that implementation of the Resource Management Plan would provide protection for fish conservation, and would not conflict with planned growth objectives of the GMA. |
| **Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl**, commonly referred to as the Northwest Forest Plan **(NFP)**, 1994. | The NFP is an integrated, comprehensive design for ecosystem management, intergovernmental and public collaboration, and rural community economic assistance for federal forests in western Oregon, Washington, and northern California. The management direction of the NFP consists of extensive standards and guidelines, including land allocations that comprise a comprehensive ecosystem management strategy. Aquatic conservation strategy objectives outlined in the NFP (Attachment A of the NFP) include, but are not limited to: "Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted;" and, "Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities." | The Proposed Action would be consistent with the intent of NFP to maintain and restore the distribution, diversity, and complexity of watersheds. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the NFP, would have a net beneficial impact on fish resources. |

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

| Federal/Tribal/State/Local | | |
|---|---|---|
| **Plans, Policies, and Programs**<br>(in chronological order of earliest to most recent) | **Description and Intent** | **Cumulative Effect when Combined with the Proposed Action** |
| **Magnuson-Stevens Conservation and Management Act, as amended through October 11, 1996 (MSCMA).** | The stated purpose of the MSCMA is "to promote domestic commercial and recreational fishing under sound conservation and management principles." The MSCMA is "to provide for the preparation and implementation, in accordance with national standards, of fishery management plans which will achieve and maintain, on a continuing basis, the optimum yield from each fishery." The MSCMS defines the term "optimum," with respect to the yield from a fishery, as the amount of fish which -- a) will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems; b) is prescribed as such on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor; and c) in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery.<br>The National Standards that serve as the overarching objectives for fishery conservation and management include: | Based on consistency with the National Standards addressed below, it is predicted that implementation of the Resource Management Plan, in combination with the MSCMA, would have a net beneficial impact on fish resources. |
| | • Conservation and management measures shall prevent overfishing. The terms "overfishing" and "overfished" mean a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce the maximum sustainable yield on a continuing basis. | • The Resource Management Plan provides for rebuilding to a level consistent with producing the maximum sustainable yield in the fishery. Consequently, the Proposed Action would be consistent with the National Standard that the management plan "shall prevent overfishing," as defined in the MSCMA. |
| | • Conservation and management measures shall be based upon the best scientific information available. | • The objectives of the Resource Management Plan include adequately addressing the criteria of a management plan under Limit 6 of the ESA 4(d) Rule. ESA requires the Secretary of Commerce to make such determinations on the basis of the best scientific and commercial data available. Consequently, the Proposed Action would be consistent with the National Standard of the MSCMA to use the best scientific information available. |

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

| Federal/Tribal/State/Local | | |
|---|---|---|
| **Plans, Policies, and Programs**<br>(in chronological order of earliest to most recent) | **Description and Intent** | **Cumulative Effect when Combined with the Proposed Action** |
| **Magnuson-Stevens Conservation and Management Act, as amended through October 11, 1996 (MSCMA)**, *continued* | • To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated populations of fish shall be managed as a unit or in close coordination. | • For harvest management purposes, the Resource Management Plan defines 15 Puget Sound chinook salmon management units. The Resource Management Plan defines a management unit as a "stock or group of [chinook salmon] stocks which are aggregated for the purpose of achieving a management objective." The Resource Management Plan places limits to the cumulative fishery-related mortality to each Puget Sound chinook salmon population or management unit throughout its entire range. Thus, the Resource Management Plan accounts for all sources of fishery-related chinook salmon mortality throughout its range. The Proposed Action would be consistent with the National Standard of the MSCMA to manage populations throughout its range. |
| | • Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches. | • As outlined in the Resource Management Plan, in managing fisheries in-season, the co-managers would implement guidelines established during the pre-season planning process to meet conservation requirements. However, these guidelines could be modified in-season based on in-season assessments of effort, catch, abundance, and escapement, while still meeting conservation requirements. Consequently, the Proposed Action would be consistent with the National Standard of the MSCMA to allow contingencies in fisheries. |
| | • Conservation and management measures shall minimize by-catch. | • The Resource Management Plan is based on limits to the cumulative fishery-related mortality to each Puget Sound chinook salmon population or management unit. The Proposed Action would limit the cumulative mortality, which includes by-catch, to these limits. Consequently, the Proposed Action would be consistent with the National Standard of the MSCMA to minimize by-catch. |

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

| **Federal/Tribal/State/Local** | | |
|---|---|---|
| **Plans, Policies, and Programs** (in chronological order of earliest to most recent) | **Description and Intent** | **Cumulative Effect when Combined with the Proposed Action** |
| **Gravel to Gravel, Regional Salmon Recovery Policy for the Puget Sound and the Coast of Washington, Western Washington Treaty Tribes, July 25, 1997 (Gravel to Gravel Policy).** | Major elements of the Gravel to Gravel Policy are to provide habitat protection and restoration, ensuring abundant spawners, managing fisheries, and integrating hatchery production. | The Proposed Action would be consistent with the Gravel to Gravel policy of managing fisheries to ensure abundant spawners. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the Gravel to Gravel Policy, would have a beneficial impact on fish resources. |
| **Policy of Washington Department of Fish and Wildlife and Western Washington Treaty Tribes Concerning Wild Salmonids (Wild Salmon Policy).** Adopted by Washington Fish and Wildlife Commission on December 5, 1997. (Despite the title, the tribal governments have not adopted this Wild Salmon Policy.) | The stated goals of the Wild Salmon Policy include restoring Washington stocks of wild salmon and steelhead to healthy, harvestable runs by "managing commercial and sport fishing to ensure enough wild runs return to spawn while providing fishing opportunities where possible." | The Proposed Action would be consistent with the Wild Salmon Policy's intent to manage commercial and recreational fishing to ensure enough wild salmon return to spawn while providing fishing opportunities where possible. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the Wild Salmon Policy, would have a beneficial impact on fish resources. |
| **Statewide Strategy to Recover Salmon, September 21, 1999 (SSRS).** | The goal of the SSRS is to "[r]estore salmon, steelhead, and trout populations to healthy and harvestable levels and improve the habitats on which fish rely." The SSRS is the long-term vision or guide for salmon recovery within the State of Washington. | The Proposed Action would be consistent with the intent of SSRS to restore salmon populations to healthy and harvestable levels. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the SSRS, would have a beneficial impact on fish resources. |
| **Local Plans, Policies, and Programs** | Local activities that influence cumulative effects to fish include, but are not limited to:<br>**Water Supply Projects:** Local water departments operate and maintain water reservoirs, pump stations, and water mains to deliver drinkable water to their customers. Local projects have minimized the adverse impacts of water withdrawal by installing additional water gauges to monitor flows and regulate water use, reducing water intake during critical environmental periods, and by purchasing existing water rights to return water to the system. | Many of these local activities are conducted in cooperation with federal, tribal, and state actions. The fisheries that would be allowed by the Resource Management Plan are predicted to have minimal to negligible effect on Washington State water quality. Because many of these local plans, policies, and programs would maintain water quality that provides for the protection and propagation of fish, it is predicted that the implementation of the Resource Management Plan, in combination with local plans, policies, and programs, would have a net beneficial impact on fish resources. |

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

| Federal/Tribal/State/Local | | |
|---|---|---|
| **Plans, Policies, and Programs** (in chronological order of earliest to most recent) | **Description and Intent** | **Cumulative Effect when Combined with the Proposed Action** |
| **Local Plans, Policies, and Programs**, *continued* | **Levee Maintenance:** A levee is a natural or manmade structure, usually earthen or riprap, which parallels the course of a river. It functions to prevent flooding of the adjoining countryside. However, it also confines the flow of the river resulting in higher, faster water flow. In recent years, local levee maintenance projects have included setting back or removing levees.<br><br>**Stormwater Management:** Surface water runoff results from rainfall or snow melt that does not infiltrate the ground or evaporate due to impervious surfaces. instead, this runoff flows onto adjacent land, or into watercourses, or is routed into storm drainage collection systems managed by local entities. Local cities and counties are in the process of developing watershed plans, subbasin plans, and revising codes to minimize the adverse impacts of surface water runoff.<br><br>**Wastewater Treatment Projects:** Municipal wastewater treatment plants process domestic sewage, and commercial and industrial wastewaters. Stormwater and groundwater infiltration may also enter wastewater treatment plants, though efforts are being made to segregate these flows. Local cities and counties are in the process of developing facilities plans and revising codes to minimize adverse impacts associated with wastewater treatment projects.<br><br>**Salmon Recovery Efforts:** Local communities are undertaking activities to protect listed species and their habitat. Examples of activities conducted include, but are not limited to: reducing barriers to fish passage; improving habitat forming processes; increasing channel diversity; improving estuarine habitat; and enhancing streamside vegetation.<br><br>**Watershed Conservation Plans:** As mandated by the 1998 state of Washington Watershed Management Act and Salmon Recovery Planning Act, counties are conducting watershed planning to address water quality, water quantity, and salmon habitat issues. | |